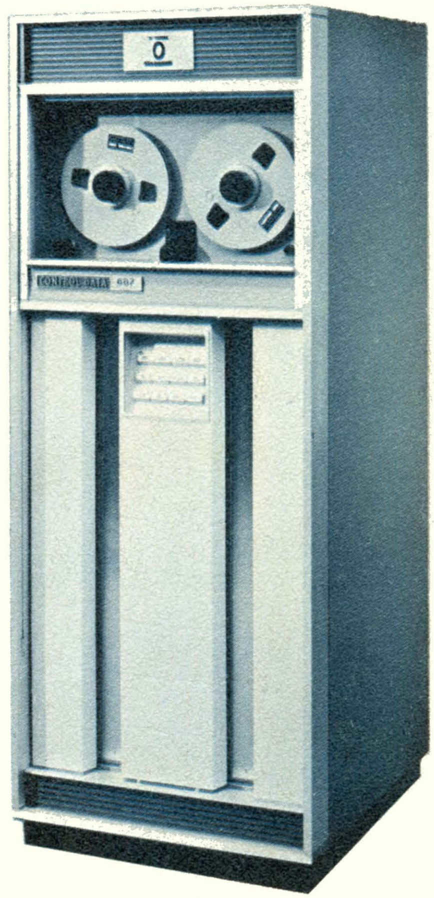
MAGNETIC TAPE STORAGE

TRAINING MANUAL



CONTROL DATA INSTITUTE CONTROL DATA CORPORATION

606 MAGNETIC TAPE STORAGE EQUIPMENT TRAINING MANUAL

FIRST EDITION

REVISION RECORD

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FOREWORD

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BASICS OF MAGNETIC RECORDING

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THE DEVELOPMENT AND THEORY OF MAGNETIC RECORDING

CHAPTER I

THE DEVELOPMENT AND THEORY OF MAGNETIC RECORDING

THE HISTORY OF MAGNETIC RECORDING

EARLY EFFORTS

Although the use of magnetic recording in data processing is relatively new, the basic concept of recording information via a magnetic medium has been a reality for more than half a century.

This concept was originally explored by Valdemar Poulsen, a Danish telephone engineer. Poulsen, often referred to as the "Danish Edison", constructed an operational magnetic recording device in 1893. He improved upon this machine, which he called the "Telegraphone", and received the first patent issued for a magnetic recording device in 1898. Though crude by modern standards, his device received the Grand Prix at the 1900 Paris Exposition.

Poulsen's machine used a steel piano wire as the storage medium with information encoded crosswise on the wire; however, a difficulty in the use of wire was its tendency to twist and bend as it passed the reproducing head, thereby causing the crosswise recording to go out of alignment. One other serious fault with the machine was the lack of amplification. This resulted in a very weak signal strength even when the quality of recording was acceptable.

The new technique showed great promise in the field of sound recording and reproduction but, due to the lack of sufficient amplification, development toward its full potential did not occur until after the invention of the triode tube by Lee DeForest in 1907.

From their inception until the later 1920's, magnetic recording devices were used primarily in laboratories where experiments resulted in changes and minor improvements to Poulsen's machine. Most of these experiments were conducted in Europe, principally in Germany. The recording medium used in these experiments was either steel wire or a steel tape.

Wire dictating machines were manufactured in Germany and met with some success. A company was formed in the United States to market the Telegraphone but American businessmen were reluctant to accept the device and the company soon folded.

At this point in the development stages the need for a more suitable recording medium was apparent. About 1920 the possibility of using a tape coated with a powdered magnetic material was suggested.

In 1927, a German inventor, Karl Pfleumer, began searching for a material to replace steel wire as a recording medium. He explored the feasibility of using a paper or plastic tape coated with a powdered magnetic material. Two German firms, AEG Company (Allgemeine Elektrizitats Gesellschaft) and BASF (Badishe Anilin - and Soda - Fabrikag) collaborated on Pfleumer's work and produced the first practical tape with a magnetic particle coating. The base of this tape was paper with an iron oxide or metallic particle coating. There is some question as to the type of material first used as a coating.

As could be expected, this tape was far from perfect. The recording surface of the tape was comparable to a rough grade of sandpaper, and the adhesive material was of such poor quality that when the tape was run on the recording machine the coating would separate from the base material in a fine spray and literally cloud the air.

About 1935, a recorder using this paper tape was exhibited and marketed. This recorder, the "Magneto-phone", was more readily accepted, though it lacked the mechanical qualities of Poulsen's Telegraphone. The deciding factor for its success was the tape which reduced the operating cost from dollars-per-recording minute, as with steel tape, to pennies-per-recording minute.

Magnetic recording activity in the United States was revived when, in 1937, Bell Laboratories developed a high quality recorder, the "Mirrophone", and Brush Development Company produced its "Sound Mirror" recorder. Both of these recorders used a steel tape as a recording medium and the "Sound Mirror" had a recording time of approximately one minute on a loop of tape.

With the world on the brink of war the sharing of technological advances, including magnetic recording, was halted. Both the U. S. and Germany could foresee the requirement for devices capable of quickly and accurately recording information. The Germans naturally took advantage of their past accomplishments and pursued the development of coated tape while the United States concentrated on steel wire and steel tape. In the late 1930's the Japanese were also exploring the field of magnetic recording.

WAR EFFORTS

As in other areas, World War II added impetus to the experiments being conducted and rapid developments were forthcoming. The Germans, by 1939, had developed a relatively good plastic tape and also a number of good recording machines, including a device with a rotating head and one with a tape speed of 30 inches per second.

In the United States, Brush was experimenting with a paper tape and also a coated wire for recording. Other companies were becoming active in the field and around 1943 Webcor was manufacturing wire recorders for the Navy. Late in 1944 Minnesota Mining and Manufacturing Company undertook experiments in an attempt to develop a recording tape using a ferro-magnetic powder as a coating.

Near the end of the war, an improved version of the German Magnetophone was captured intact and, at the conclusion of the war, the American recording industry reaped the benefits of German research and ingenuity.

From this time steel wire and steel tape, as a recording medium, was replaced with plastic-base tape. Magnetic tape recording became a household term as numerous manufacturers produced home recorders as well as recorders for industrial and business applications.

COMPUTER TAPE SYSTEMS

REQUIREMENTS

With the advent of computers and their ultimate wide-spread use in everyday life, there arose a need for a device capable of rapidly exchanging information with computers. The device should also have the capability of retaining the large amount of data generated by these computers.

About 1947 the use of magnetic recording devices in computer systems was initiated. Since this time the development and improvement of magnetic recording devices and magnetic tape has progressed hand in hand with the development and improvement of computers.

The speed of modern data processing computers is such that extensive files of data are needed for economical use of the machine's capability. The day has come when the slow process of manually feeding information into a computer is too time consuming to be tolerated.

The speed of the automatic computer system is derived primarily from the stored-program concept wherein both the program and the information to be operated upon are contained within the Memory Section. Memory is very expensive, and the economy of a system is impaired by including a memory larger than absolutely necessary. An auxiliary memory, freeing main memory for computation programs and data, is desirable. An auxiliary memory is needed which has the ability to place in main memory the program and information to be used immediately, to store that which will eventually be needed, and to return to storage that which has been used. A solution to this need was magnetic tape.

Magnetic tape's greatest advantage is the high transfer rate of data between the tape and the computer in both directions. With its use, the necessary memory space can be held at a minimum. A scheme is to reserve an area of memory for the program and an area for the information to be operated upon. As the instructions are being read and executed in one portion of memory, another portion can be prepared with new instructions and information stored in the newly-prepared area. The contents of the old area can be stored on tape. This is one of the ideas used with the Scope/Compass Library Tape and does reduce the size of memory needed to process even huge volumes of data.

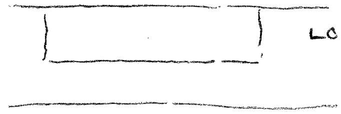
Magnetic tape, then, serves as auxiliary memory for program instructions or information where access times longer than that in main memory can be tolerated.

Tape also has the ability to physically condense the extensive files needed. For example; the 3200 Computer, when fully expanded with the maximum number of storage modules, can contain 32K of memory. This means the largest memory available can contain 32,768 words of 8 octal digits, or 24 bits each, in length.

One punched card can contain forty 3200 computer words. Thus:

$$\frac{32,768}{40} = 819.2 \text{ punched cards}$$

7-TRACK MARKER 1 X 1/2 INCH



LOAD POINT MARKER
15-18 Feet Beginning
25 feet END

This means it would take 820 punched cards to completely load the memory.

There are 28,464 usable inches of tape on one standard reel of magnetic tape. The contents of memory loaded from the 820 cards could be written on 164 inches of the tape.

$$\frac{28,464}{164} = 173.56 \text{ memories of 32K each}$$

A roll of tape, then, could contain enough information to completely load memory 173 times and could contain as much information as 142,180 cards.

$$819.9 \times 173.56 = 142,180.4 \text{ punched cards}$$

As an average, there are 131 punched cards per inch in a vertical stack. The punched cards needed to provide data to fill a reel of magnetic tape would be

$$\frac{142,180.4}{131} = 1,085.4 \text{ inches, or}$$

a stack over 90 feet high.

PROBLEMS

Within the Magnetic Tape System there are problems which must be solved for proper operation of the system. The problems generalized are: speed, word size, parity, and control signal exchange.

IRG 3/4" LONG MAY CHANGE TO HEAT/COLD

Speed

The computer is capable of placing a 12-bit word on the channel every 1.25 usec during output or of accepting a word at the same rate during input. The tape transport is capable of reading or writing the word in 16.9 usec in its fastest operation. The first problem to be solved in the system, then, is to control and synchronize the operation to accomodate the difference in computer and tape transport speeds.

Word Size

The computer channel uses a 12-bit byte while the transport uses a 6-bit information frame. During output, the 12-bit word must be disassembled to provide 2 frames for tape. During input, 2 frames must be assembled into the 12-bit word for the computer channel's word. The second problem is then proper assembly and disassembly.

Parity

The number of "1" bits in the word or the frame is used to determine the accuracy of the operation.

On the channel, parity is always odd as data moves in either direction. During output, parity must be checked to determine that there are an odd number of bits coming from the computer. During input, a parity bit may be necessary to make parity odd going to the computer. Something has to check and generate the required parity bit.

On the transport lines, the parity designates the frame of data to be a binary quantity or a binary coded decimal (BCD) quantity. Each BCD code represents a letter, number, or character.

The third problem, that of parity, has many facets, and its solution is to assure accuracy in the operation.

Control Signal Exchange

The computer channel has specific control signals to indicate its operation. The signals are not restricted to a single system but, instead, will be applied without concern to Tape System, Card System, Printer System, etc.

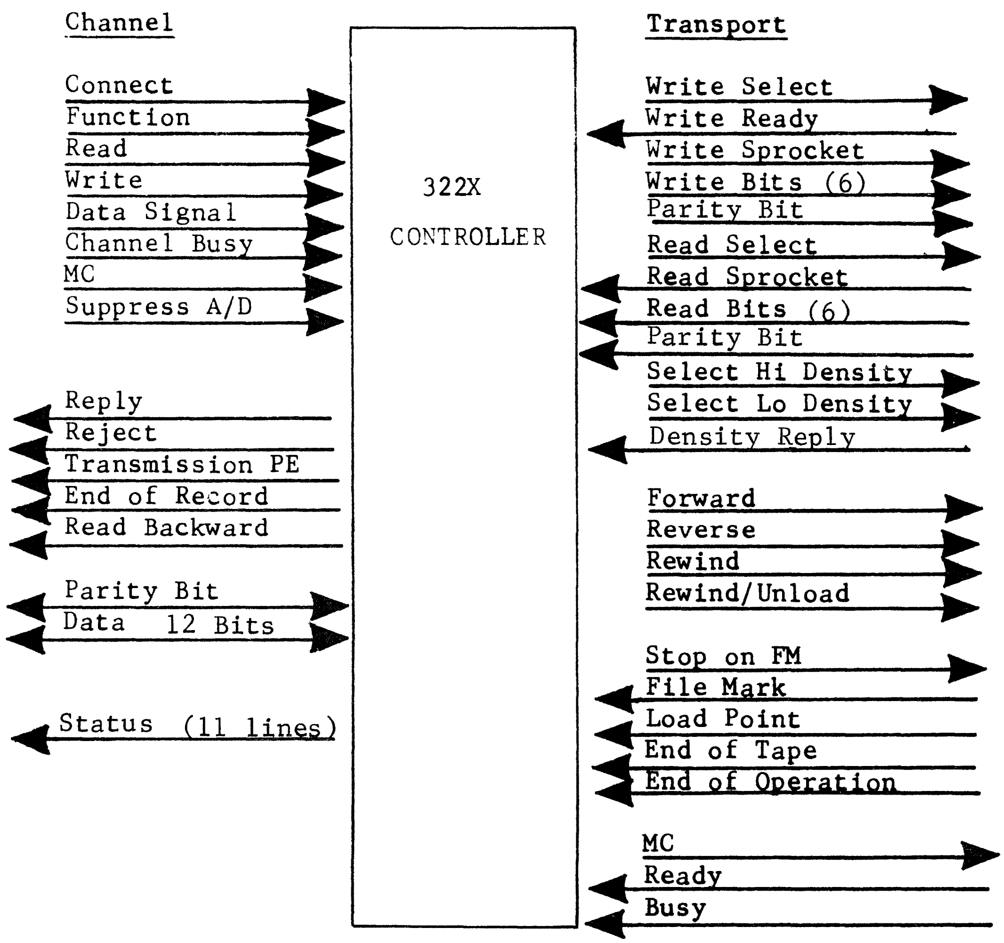


Figure 1-1-1

The problem for solution is then translation or interpretation of each signal so a proper exchange of signals may occur to control the operation.

Figure 1-1-2

These problems are solved within the controller, and a tape system must be made up of the channel, a controller and the tape handler (see Figure 1-1-2).

A Connect signal from the channel designates the system (tape, card, printer) with which the operation will progress. In the case of the tape system more than one handler may be accessed through the controller so the Connect signal must also designate a specific handler.

Communications for a Read operation (data transfer to computer) would be:

1. A Read signal from the computer Channel indicates that an input word is required by the computer.
2. The controller responds to the Read signal by sending a Forward (or Reverse) signal to move tape on the transport while simultaneously enabling the transport's read circuitry with a Read Select signal.
3. The transport sends frames of information (Read Bits) to the controller. Each frame is accompanied by a Read Sprocket signal.
4. The controller assembles the frames into a word of suitable length for the channel, in this case only two frames are required. When the word has been assembled, the controller generates a parity bit for the word, places the data word and parity on lines to the computer Channel and issues a Reply signal to the Channel.
5. Upon receipt of the Reply signal, the Channel transfers the data word and associated parity bit and drops the Data signal to the controller.
6. Loss of the Data signal causes the controller to drop the Reply signal to the Channel.

Communications for a Write operation (data transfer to transport) would be:

1. A Write signal from the computer Channel indicates that an output word is being sent to the controller.
2. The controller responds to the Write signal by sending a Forward signal to move tape on the transport while simultaneously enabling the transport's write circuitry with a Write Enable Select signal. The controller then gates in the Data word and associated Parity Bit and sends a Reply to the Channel.

3. Receipt of the Reply signal by the Channel causes the Data signal to drop.
4. Meanwhile, the controller checks for parity errors of the data transmission and if none occurred, begins disassembly of the data word into frames suitable for the transport. At the appropriate time a frame is sent to the transport (Write Bits) along with a Write sprocket signal. It repeats this until both frames have been written on tape. Loss of the Data signal causes the controller to drop the reply signal.

The Function signal indicates operations such as indexing, conditioning, or other special operations are to be made in the controller or handler. The Reply acknowledges the operation, and indicates it has been or will be performed.

CONSTRUCTION OF MAGNETIC TAPE

The construction concept of magnetic tape is quite simple: particles of iron oxide are spread on and made to adhere to a thin ribbon of plastic which is wound on a reel. There are three basic ingredients that are used to make magnetic tape: 1) oxide coating, 2) binder, 3) backing or base material.

OXIDE COATING

The magnetic layer consisting of oxide particles held in a binder that is applied to the base film is called the oxide coating. The ferromagnetic material is gamma-ferric oxide, Fe_2O_3, in the form of acicular (needle-shaped) particles less than one micron in length (1/1000 of a millimeter or 0.000039 inches). It is very important that the oxide coating is both uniform and smooth. For computer tapes, this means that the coating thickness must be .00045 inches along the entire 2400 feet length. If the oxide particles are not uniform in size, the surface of the tape will be rough, making the tape more abrasive. This could cause reduced head life and greater oxide contamination. Non-uniformity in thickness lends itself to variations in average peak signal output. Most tape specifications call for the average peak signal output to vary no more than $\pm$ 10% at 800 bits per inch (BPI).

BINDER

The substance, usually composed of organic resins, used to bond the oxide particles to the base material is called the binder. The actual composition of the binder is proprietary information to the magnetic tape manufacturer; therefore, little is known about this component except that it is probably the most important part of the manufacturing process. The binder must be flexible and tough without having the oxide chip or flake off. If the binder's consistency is sticky, the individual tape layers will adhere to each other when wound on a reel.

BASE MATERIAL OR BACKING

The most common type of backing in use today for computer tape is Mylar, the DuPont trade name for Polyethylene terephthalate. The chief advantages of this polyester over other base film lies in its humidity stability, its solvent resistance, and its mechanical strength.

Cellulose acetate, which preceded Mylar, is relatively strong but not as stable as Mylar. Cupping is an undesirable feature of cellulose acetate which will render a computer tape completely useless.

Other backing materials are in use today such as Tenzar, a 3-M product, Polyvinyl Chloride, and Luvitherm, a BASF (Badische Anilin - & Soda - Fabrikag) product. These plastics have yet to play a large part in the construction of magnetic tape.

THEORY OF MAGNETISM

CLASSES OF MAGNETS

Magnets are classified as being natural or artificial according to the manner in which they are formed. The ancient Greeks knew that certain stones found in the town of Magnesia in Asia Minor had the property of attracting bits of iron. These stones were called magnetite and, as we know today, this is an iron ore possessing magnetic qualities.

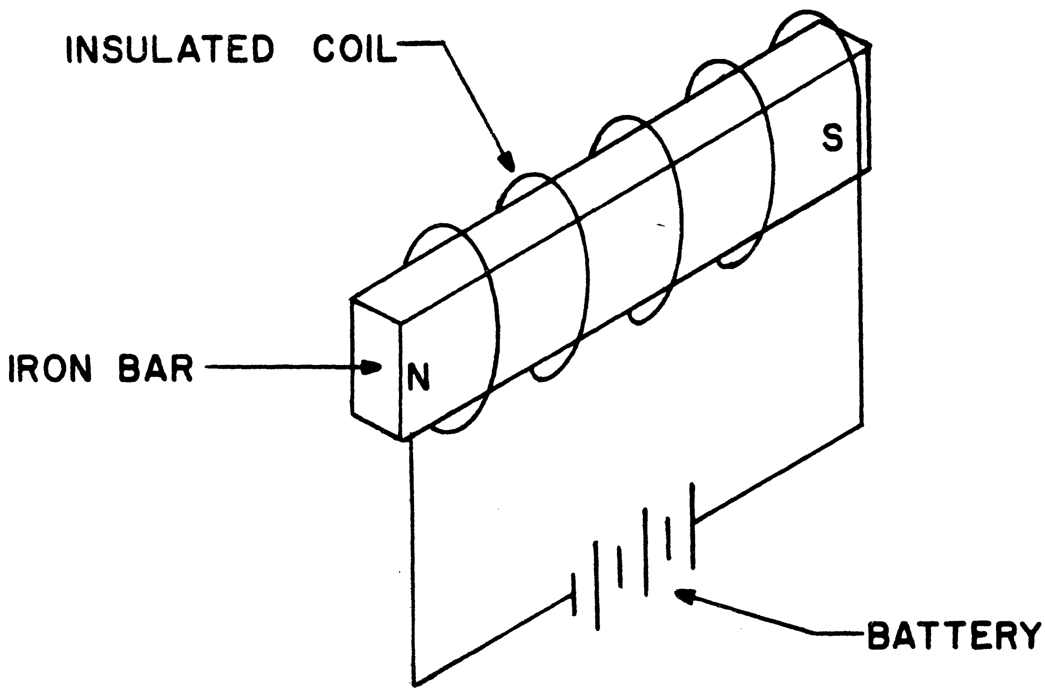
Although useful in the days of the ancient Greeks, magnetite, a natural magnet, has only historical value today. Stronger and more efficient magnets can be produced by artificial means.

An artificial magnet can be formed by placing a bar of iron or steel in a coil of insulated wire and passing a current through the coil as shown in Figure 1-1-3A. As the current passes through the coil, magnetic poles are formed as indicated by N representing the North Pole and S the South Pole. The bar is said to be magnetized.

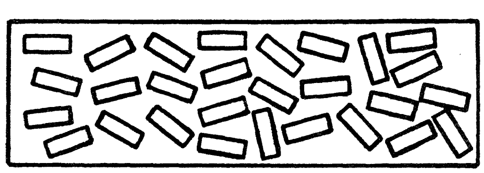
The molecular theory of magnetism is illustrated in Figure 1-1-3. Figure 1-1-3B shows a piece of unmagnetized iron where each molecule is considered to be a tiny magnet. These molecular magnets are arranged in a random manner. The magnetism of each of the molecules is neutralized by adjacent molecules and no external magnetic effect is produced. When a magnetizing force is applied to the iron bar, the molecules align themselves so all North Poles (N) point in one direction and all South Poles going in the other direction as shown in Figure 1-1-3C.

TYPES OF ARTIFICIAL MAGNETS

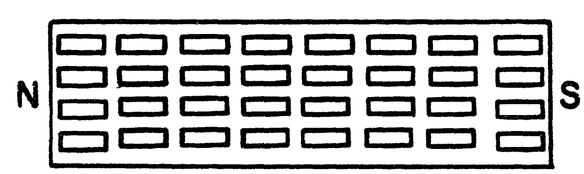
An artificial magnet may be either of two types--"Permanent" or "Temporary"--depending on its ability to retain magnetic strength after the magnetizing force has been removed. Hardened steel and certain alloys are relatively difficult to magnetize and are said to have a low permeability because the magnetic lines of



A. Forming an Artificial Magnet



B. UNMAGNETIZED



C. MAGNETIZED

Figure 1-1-3. Molecular Theory of Magnetism force do not easily permeate, or distribute themselves readily through the steel. These materials, however, do retain a large part of their magnetic strength and are said to be permanent. This abiltiy of a material to retain its magnetic strength is referred to as the retentivity of the material.

Soft iron has a high permeability and is called a temporary magnet due to the fact that it can retain only a small amount of its magnetic strength when the magnetizing force is removed.

Figure 1-1-4 illustrates a bar magnet and some of the facts that are known about magnets.

MAGNETIC PRINCIPLES

All magnets have two poles--a North Pole (N) and a South Pole (S). A magnetic field exists around the bar magnet. This field consists of imaginary lines along which a magnetic force acts. These lines emerge from the North pole of the magnetic and enter the South pole, returning to the North pole through the magnet itself and forming closed loops. The entire quantity of magnetic lines surrounding a magnet is called magnetic flux while the number of lines per unit area is called flux density.

If a bar magnet is bent to form a loop without the ends touching (as shown in Figure 1-1-5), a magnet will be formed having a magnetic field that is of shorter length and greater concentration then the bar magnet.

One characteristic of the imaginary lines in a magnetic field is that they tend to take the path of least reluctance (magnetic resistance). In other words, they pass through the material that has the greater permeability. Air offers more reluctance to the lines of force than does iron or steel.

If a piece of iron is brought into proximity with the gap of the horseshoe magnet, as shown in Figure 1-1-6, the lines of force will tend to bend so as to pass through the iron. The piece of iron will become magnetized by the imaginary lines flowing through it. This characteristic of magnetism, referred to as induction, is utilized in the process of magnetic recording.

THE ELECTROMAGNET

If an electric current flows through a piece of wire, a magnetic field is built up around the current-carrying conductor. Referring again to Figure 1-1-1, when a coil of wire is placed around a piece of iron and a current flows through the coil, the magnetic field of the coil magnetizes the iron bar. A device of this type is called an electromagnet. If the direction of current flow is reversed the polarity of the magnetized core will reverse.

The core of the electromagnet can be in the shape of the horseshoe magnet of Figure 1-1-7. An electromagnet of this configuration is basically the type of device used as a "Write" head in a magnetic tape recorder.

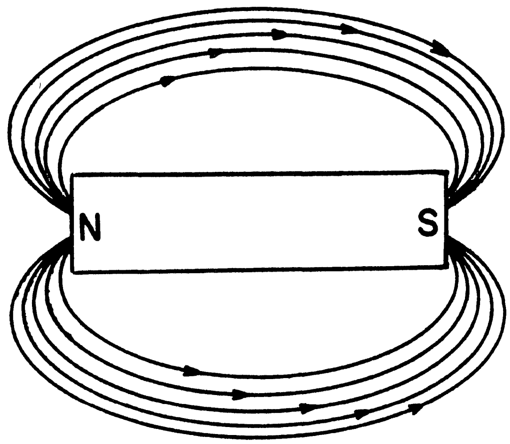


Figure 1-1-4. Magnetic Lines of Force

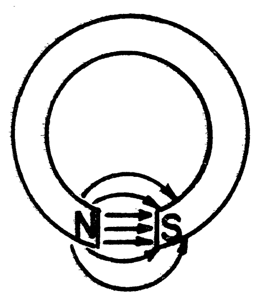


Figure 1-1-5. "Horseshoe" Magnet Showing Concentration of Magnetic Field

In Figure 1-1-7 an electromagnet is shown with another magnet being passed close to the gap. As the magnet passes, its lines of force will flow through the core of the electromagnet and a current will be induced in the coil. This is basically the idea behind "Reading" information from a magnetic tape.

THEORY OF MAGNETIC RECORDING

SURFACE RECORDING WITH ALTERNATING CURRENTS

One fundamental method of recording on tape involves the magnetization of minute areas on the surface of a highly retentive magnetic material. In order to reproduce the recorded information, the magnetic state of the material is "Read" back by using the retained or residual flux to induce voltages in the read circuits. This method, commonly called surface recording, is used to record information on magnetic tape.

Magnetic surface recording is based on the interaction between a material, such as magnetic tape, and a magnetic head (transducer) in relative motion.

Writing

First we will explore surface recording; the process of "Writing" on a magnetic tape. In order to accomplish this, there must be a basic understanding of the construction of the recording or "Write" head.

It was pointed out in the section on magnetism that a horseshoe magnet has an air gap through which a magnetic field or magnetic flux is present. This magnetic field is comprised of invisible lines of force that emanate from the North Pole of the magnet and enter the South Pole, making a closed loop.

The recording or "Write" head used in magnetic tape recording is basically an electromagnet similar to the horseshoe magnet discussed earlier.

Figure 1-1-8 (A) is a simplified drawing of a recording head having no current flowing in the coil and, consequently, no magnetic field. In order to generate a magnetic field, current must flow in the coil, as shown in Figure 1-1-8 (B). If current is flowing as indicated by the arrows, an electromagnet is formed with North and South Poles and lines of force as indicated. In Figure 1-1-8 (C) the direction of current flow has been reversed. Note that the poles of the electromagnet reverse with the resultant reversal in the direction of the lines of force.

Based upon the foregoing principles, the events which occur when a magnetic tape is brought into contact with the head can be more easily understood.

The fact has already been pointed out that magnetic tape is constructed of a plastic base coated with a material that has the capability of being magnetized and of retaining that state of magnetization for an indefinite period of time.

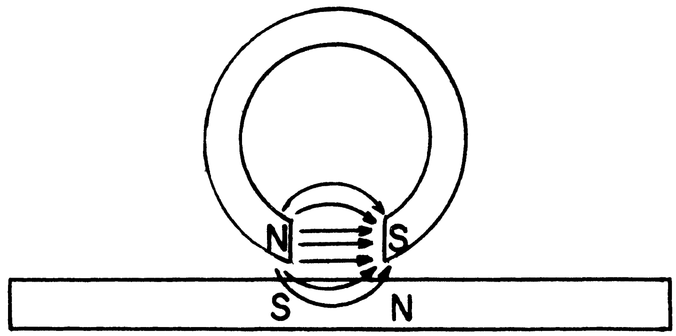


Figure 1-1-6. Lines of Force Inducing Magnetism

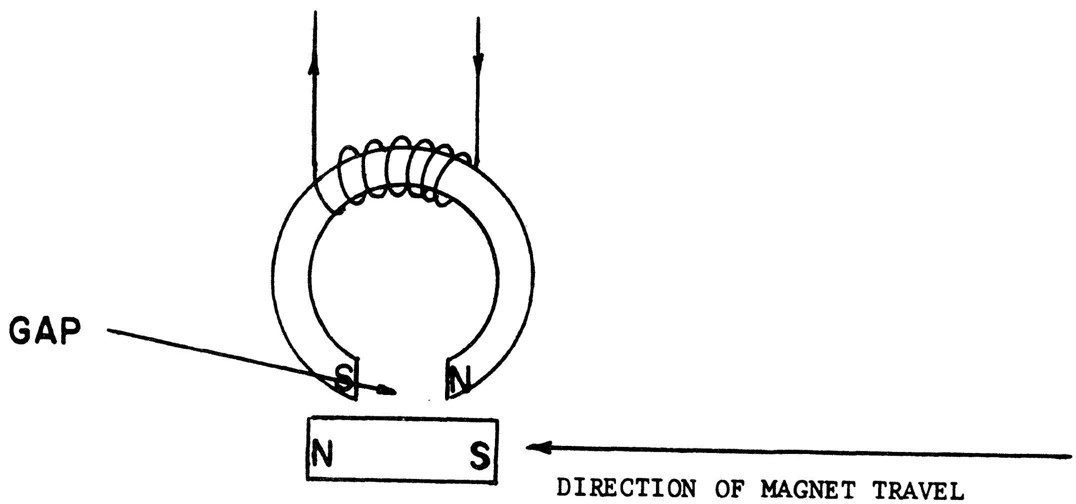


Figure 1-1-7. Inducing Current in a Coil

Figure 1-1-9 (A) shows the recording head with no current flowing in the coil; therefore, a magnetic field is not present and no change takes place on the surface of the magnetic tape. In Figure 1-1-9 (B) the head is shown with current flow and the resulting magnetic field. The magnetic field passes through the surface of the tape and changes the magnetic polarity of a small area. The current direction is reversed in Figure 1-1-9 (C) and, as shown, a different condition exists on the surface of the tape.

It was previously pointed out that surface recording is dependent on relative motion between the recording head and the tape. Figure 1-1-10 (A) shows the relationship of a fixed recording head with magnetic tape moving in the direction shown. The illustration also shows one cycle of an alternating current and the resulting current flow through the coil. Note that the current flow through the coil reverses with a change from positive to negative direction and the polarity of the recorded information on the tape also reverses.

We have examined only one cycle in the process of recording on tape. This could be continued for any number of cycles with each one establishing two definite areas of magnetized tape of opposite polarity.

Reading

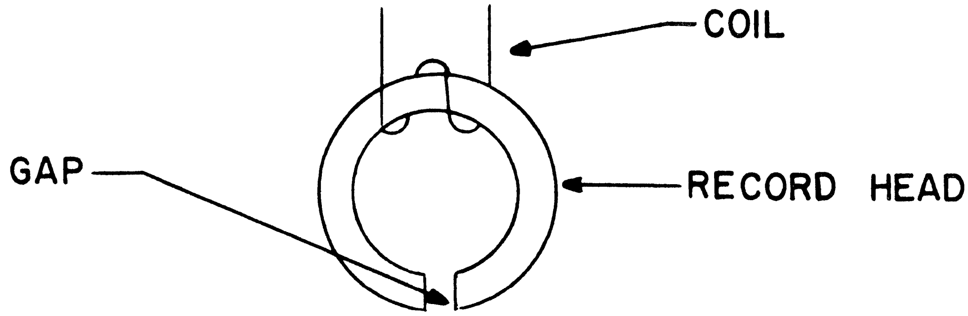
In the "Read" or reproduce operation a previously recorded tape will move into the vicinity of the read head gap. It should be pointed out that the "Read" head is quite similar in construction to the "Write" head.

Figure 1-1-10 (B) shows a stationary head with the tape being moved in a given direction. In this illustration we are interested in a changing magnetic field associated with one alternation. As the tape passes under the read head, the changing polarity of the recorded information on tape induces a current in the read head coil. Note that a current is produced in the coil only when the magnetic field on the tape changes. When the information is read from tape it in no way alters the magnetic state of the tape so that a recorded tape can be read an indefinite number of times.

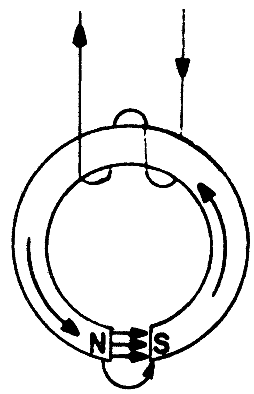
SURFACE RECORDING DIGITAL INFORMATION

In the preceding discussion we have been concerned with an alternating current inducing a change in the magnetic state of the tape. In recording digital information, as encountered with digital computers, we are concerned with recording information represented by pulses which represent the binary states of "1" and "0".

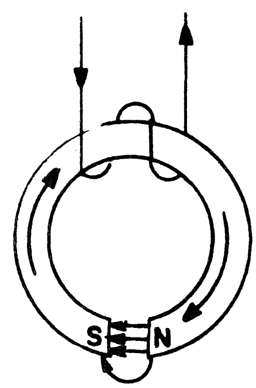
There are numerous schemes for recording digital information, but we will consider only the most common one -- the one used in Control Data Tape Transports and the Control Data Tape Certifier. This recording scheme is referred to as the Non-Return-To-Zero, Change on Ones (NRZ1) method. (This particular method is also designated Non-Return-To-Zero, Indiscrete (NRZ1).)



A. NO CURRENT THROUGH COIL

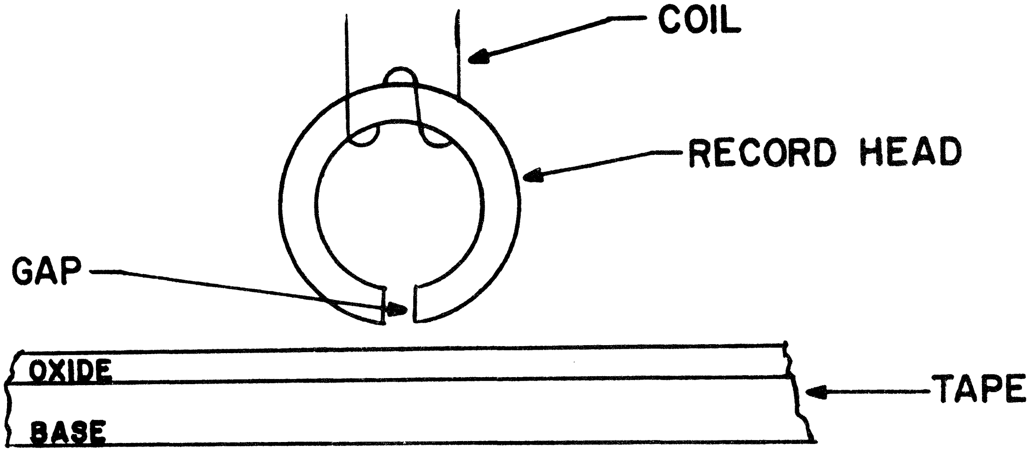


B. CURRENT THROUGH COIL

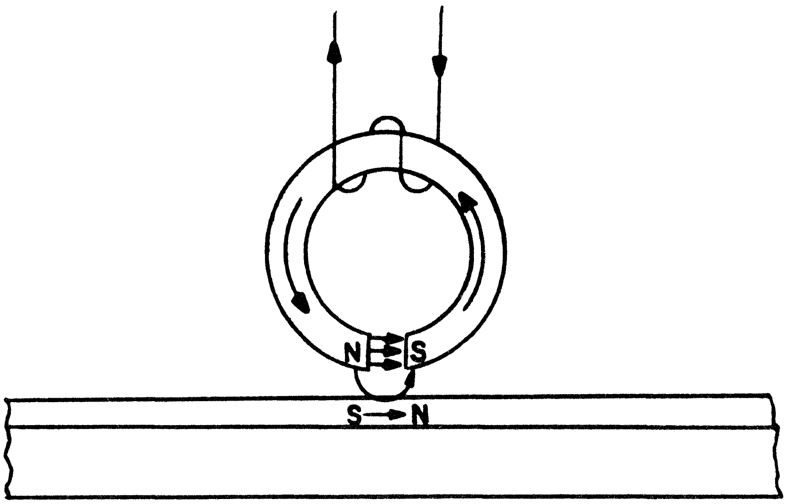


C. CURRENT REVERSED

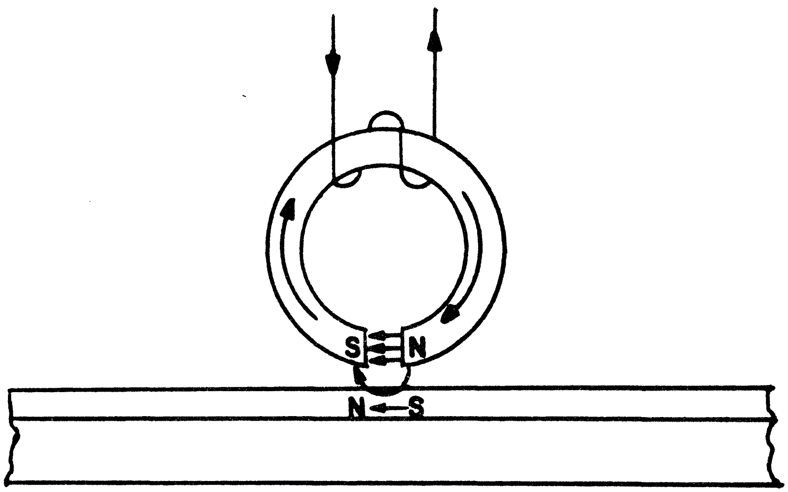
Figure 1-1-8. Simplified Drawing of Recording Head



A. NO CURRENT THROUGH COIL



B. CURRENT THROUGH COIL



C. CURRENT REVERSED

Figure 1-1-9. Recording on Magnetic Tape

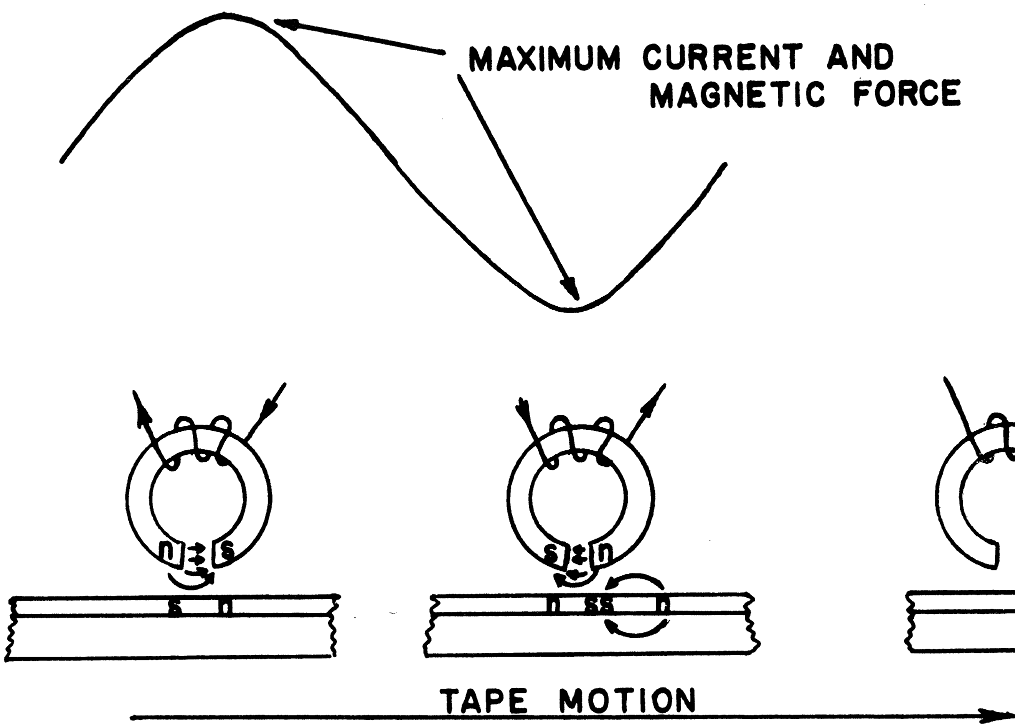
The illustration is Figure 1-1-11 shows the "Write" current applied to the coil of the write head, the flux configuration of the magnetized particles on tape, and the signal developed as the tape is read.

Note that a change in the Write current occurs only when a "1" is to be recorded whereas during the period when "0's" are recorded, the write current remains at the same level. A change in the flux pattern on tape occurs only when the write current changes (a "1" is to be recorded). A change in the flux pattern on tape does not occur if the write current does not change ("0's" are recorded).

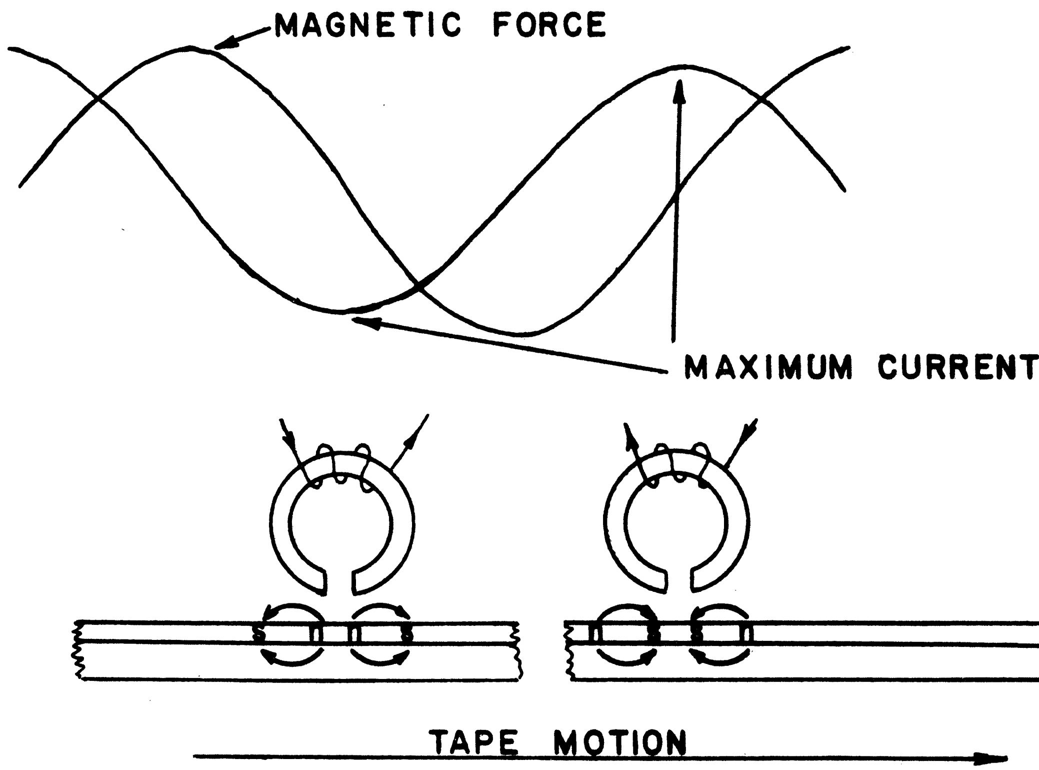
During a read operation, a read signal is produced only when a change in the flux pattern on tape is encountered, signifying that a "1" had been recorded. When a change in the flux pattern is not present, zero's are read.

The material presented in the foregoing is intended to be only a brief description of basic theory of tape recording and one of the recording schemes necessary for a more thorough understanding of tape certification.

In Figure 1-1-11, only one track is considered. Present-day industry standard for a compatible recording format consists of a seven-track NRZ1 recording scheme. The recording head in the standard Control Data transport, using standard ½-inch tape, contains 7 separate read and write heads, one for each track.



A. RECORDING (WRITE OPERATION)



B. REPRODUCING (READ OPERATION)

Figure 1-1-10. Relative Head to Tape Motion

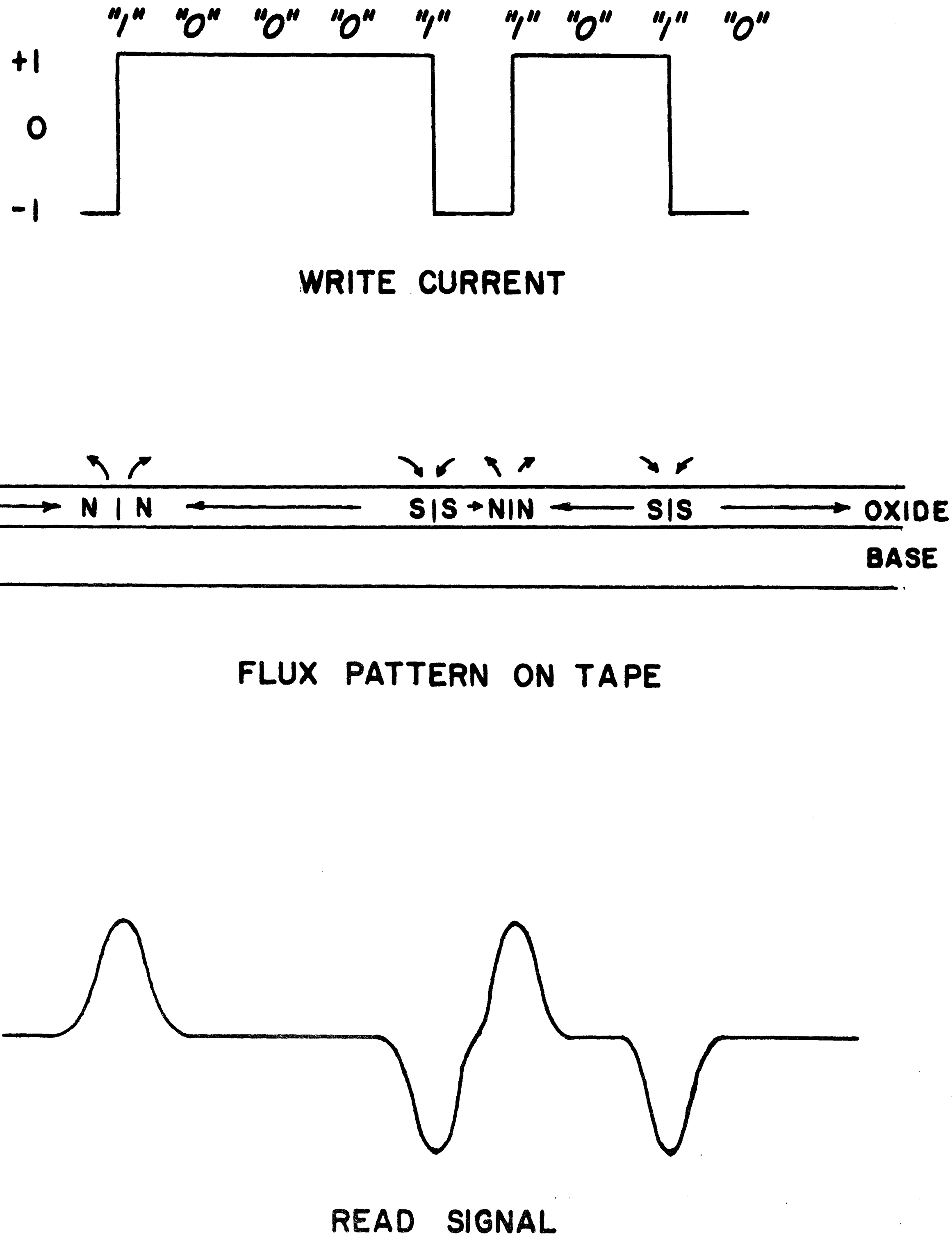


Figure 1-1-11. Non-Return-to-Zero, Change on Ones

CHAPTER II

COMPUTER TAPE CONSIDERATIONS

CHAPTER II

COMPUTER TAPE CONSIDERATIONS

TAPE FORMAT

Data is recorded on tape in a specific way to facilitate its rapid recovery. Just as the text-book has divisions which we know as chapters, paragraphs, and sentences, so a tape is divided into a logical format. Perhaps you have never considered the reason for division in written text, but does it not appear a system is in common usage to aid the reader to quickly index or reference his text. It is divided into completed thoughts and subjects. A tape is similarly divided into reference groups of related data. An understanding of the formats employed in tape will aid in your understanding of the programming and operational requirements of the equipment.

REFLECTIVE MARKERS

Two reflective markers are required on a processed tape, one near the beginning of the tape (B.O.T. or load point) and one near the end of the tape (E.O.T. marker, Figure 1-2-1). The reflective markers are physically attached to the tape and are necessary to prevent damage to the tape and loss of data. Generally, the Beginning of Tape or Load Point marker is used in the loading of the machine or in a rewind operation. In the load operation, the machine will move tape forward until the Beginning of Tape marker is sensed. This, then, allows the computer program to locate the start of recorded information on the tape. In a rewind operation, the Beginning of Tape marker will stop the high-speed reverse motion of the tape transport. The End of Tape marker will not stop tape motion if the tape transport is under computer control. Since, at the time the End of Tape marker is sensed a write operation may be in progress, it would mean a loss of data if tape motion were halted. Therefore, tape motion continues until the write operation is complete.

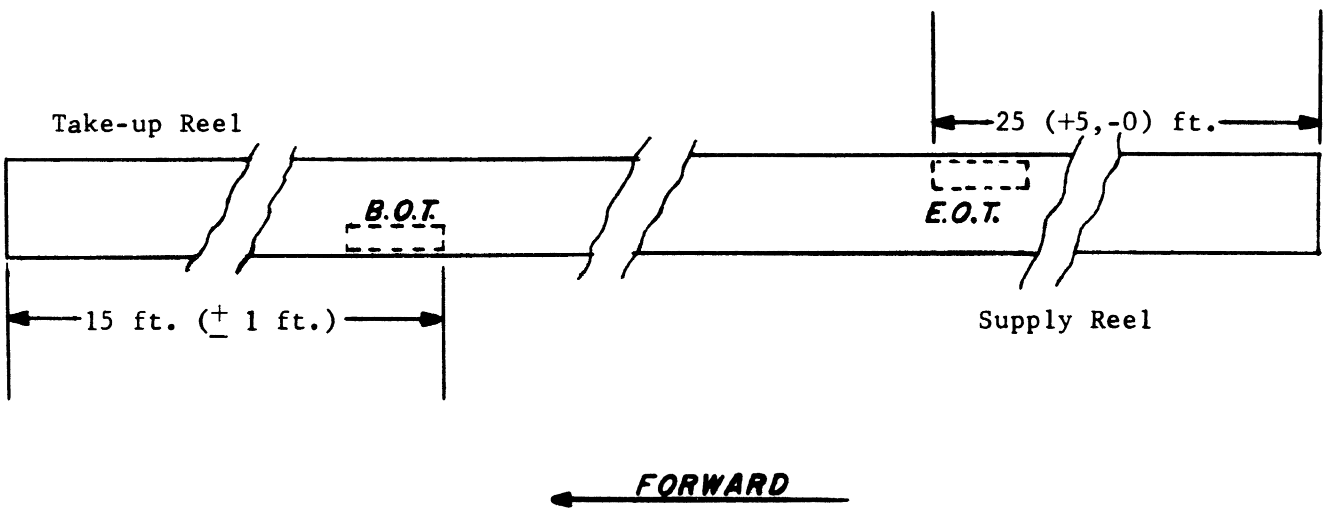
The markers are placed on the base (uncoated) side of the tape and on opposite edges. The physical location of the markers determine whether they will be sensed as Beginning of Tape or as End of Tape Markers.

The reflective markers are constructed of an adhesive strip with a highly reflective coating of vaporized aluminum. Usually, these markers are 1 inch in length and 3/16 of an inch in width, having a thickness of 0.0005 inch.

POSITIONING

1. The Beginning of Tape marker must be placed fifteen (15) feet $\pm$ one foot from the physical beginning of the tape with the one-inch dimension parallel to and not more than 1/32 of an inch from the track 0 edge of the tape. (The edge nearest the operator when the reel is mounted.)

2. The End of Tape marker must be placed a minimum of twenty-five feet (plus five feet, minus zero feet) from the physical end of the tape with the one-inch dimension parallel to and not more than 1/32 of an inch from the track 6 edge of the tape. (The edge nearest the machine when the reel is mounted, as shown in Figure 1-2-1.)



NOTE: **Tape is shown with oxide surface facing up.**

Reflective Marker Placement

Figure 1-2-1-1

PROCEDURE

1. Place markers on the tape with care to avoid contamination or damage.
2. Perform work on a suitable, flat, stationary surface while mounting the tape on the transport.

3. Align the markers properly.
4. Press down firmly and smoothly on the markers with the flat of the fingernail to remove air bubbles.
5. Do not allow loose end of the tape to become contaminated.

GROUPING

The data or information written on the tape is recorded, we have found, by affecting the magnetic polarity of the oxide coating in spots or areas. The physical arrangement of the head allows simultaneous operation in seven distinct tracks on the tape. Information is divided into frames, records, and files.

FRAME

The simultaneous recording of one (1) bit by each of the seven recording heads producing 7 bits that are aligned nearly perfectly across the width of the tape (Figure 1-2-2).

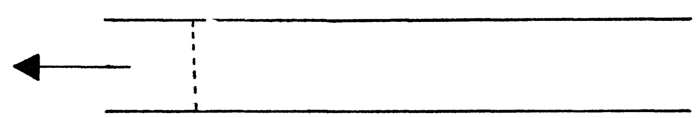


Figure 1-2-2

TRACK

The information recorded longitudinally by a single recording head. Seven such tracks are currently standard on tape.

RECORD

The data recorded by one output instruction. This instruction can output any number of frames. All of the frames of a record are grouped together. Records are separated from each other by 3/4" record gap.

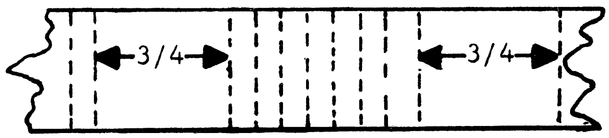


Figure 1-2-3

FILE

A File is a group of records, usually containing related data or information. The file may contain one or any number of records. Files are separated by the File Mark. A File Mark is the BCD Code 17 recorded on the tape. The File Mark is written six inches from the last record in the file and 3/4 of an inch from the first record in the next file. This mark is unique and can be located at will by programming to provide a reference point or index within the reel.

A photograph of actual data recorded on tape can be seen in Figure 1-2-4. The tape was prepared by dipping it into a solution of Magna-See*, which is a solution consisting of powered iron and heptane. The heptane evaporates leaving only the iron particles which have collected on recorded areas.

ERROR DETECTION

A constant check is made to determine the presence of error during operation. The checks within the tape system are based on the number of "1" bits present in the data, compared with an indication of whether those bits should total odd or even.

PARITY

Parity is a lateral or vertical check of the data frame. The six information bits are evaluated during the write operation, and the seventh bit is assigned as a "1" or a "0" to make the frame total an odd or an even number of "1" bits as required for the mode of operation. During Read, a similar check is made to determine if the data is still error free.

* Product of Reeves Soundcraft.

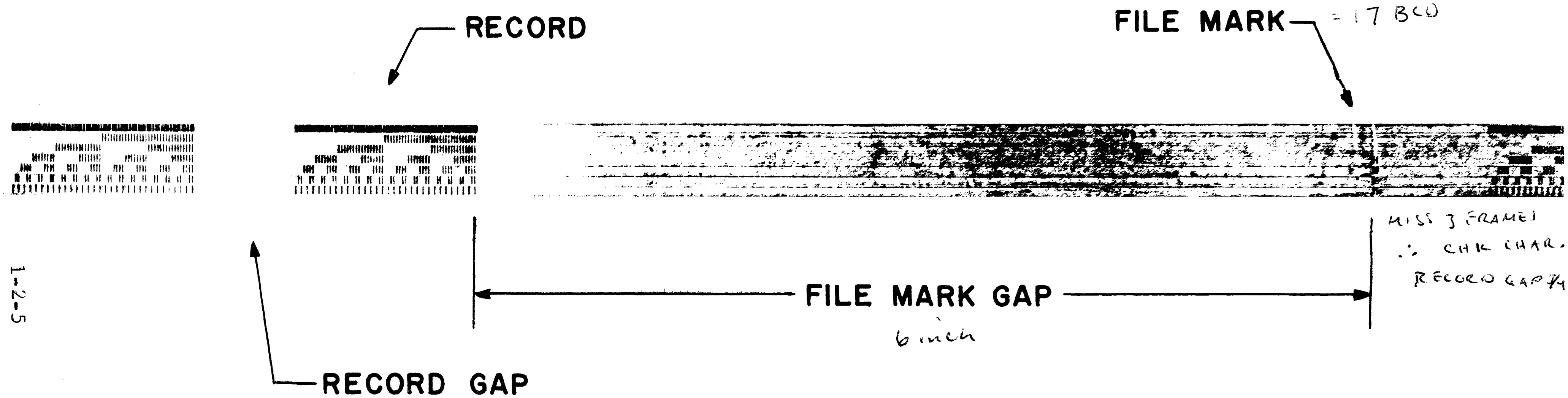


Figure 20A. Actual Recording on a Computer Tape

Binary -- Odd Parity

Binary information is the numerical information in the same form as it is represented in the Computer's Memory. The six information bits from a disassembled 12-bit byte forms a frame of information which is evaluated during Write. If the number of "1" bits total even, a "1" bit is assigned to the 7th track making an odd number of bits in the total frame. If the number of "1" bits total odd, a "0" bit is assigned to the 7th track leaving the frame with an odd number of bits.

During a Read operation, the six information bits are evaluated. If the total of "1" bits is odd, the 7th bit should be a "0". If the total of the six information bits is even, the 7th bit should be a "1". A circuit checks for these conditions and a Parity Error occurs if the check proves untrue.

In the binary format, the six information bits from the computer could be all zeros and evaluated as an even number of "1" bits. A "1" bit assigned to the 7th track would make parity odd or, in other words, it puts a single "1" bit in the frame. Each frame must contain at least one "1" bit.

TABLE 1-2-1. MAGNETIC TAPE BCD CODES

Magnetic Tape Unit Characters	Internal BCD Codes	External BCD Codes	Magnetic Tape BCD Codes	Punched Card Codes
0 (zero)	00	12	82	0
1	01	01	C1	1
2	02	02	C2	2
3	03	03	21	3
4	04	04	C4	4
5	05	05	41	5
6	06	06	42	6
7	07	07	C421	7
8	10	10	C8	8
9	11	11	81	9
---	12	(illegal)		2.8
#	13	13	C821	3.8
@	14	14	84	4.8
---	15	15	C841	5.8
---	16	16	C842	6.8
(tape mark)	17	17	8421	7.8
&	20	60	BA	12
A	21	61	CBA1	12.1
B	22	62	CBA2	12.2
C	23	63	BA21	12.3
D	24	64	CBA4	12.4
E	25	65	BA41	12.5
F	26	66	BA42	12.6
G	27	67	CBA421	12.7
H	30	70	CBA8	12.8
I	31	71	BA81	12.9
+0	32	72	BA82	12.0
	33	73	CBA821	12.3.8
	34	74	BA84	12.4.8
---	35	75	CBA841	12.5.8
---	36	76	CBA842	12.6.8
(group mark)	37	77	BA8421	12.7.8
_ (minus)	40	40	CB	11
J	41	41	B1	11.1
K	42	42	B2	11.2
L	43	43	CB21	11.3
M	44	44	B4	11.4
N	45	45	CB41	11.5
O	46	46	CB42	11.6
P	47	47	B421	11.7
Q	50	50	B8	11.8
R	51	51	[illegible]1	11.9 CB81
-0	52	52	[illegible] CB82	11.0 CB82
$	53	53	[illegible] B821	11.3.8 B821
*	54	54	CB84	11.4.8 CB84

TABLE 1-2-1. MAGNETIC TAPE BCD CODES (CONTINUED)

Magnetic Tape Unit Characters	Internal BCD Codes	External BCD Codes	Magnetic Tape BCD Codes	Punched Card Codes
---	55	55	B841	11.5.8
---	56	56	B842	11.6.8
---	57	57	CB8421	11.7.8
(blank)	60	20	CA	(blank)
/	61	21	A1	0.1
S	62	22	A2	0.2
T	63	23	CA21	0.3
U	64	24	A4	0.4
V	65	25	CA41	0.5
W	66	26	CA42	0.6
X	67	27	A421	0.7
Y	70	30	A8	0.8
Z	71	31	CA81	0.9
(record mark)	72	32	CA82	0.2.8
(comma)	73	33	A821	0.3.8
%	74	34	CA84	0.4.8
---	75	35	A841	0.5.8
---	76	36	A842	0.6.8
---	77	37	CA8421	0.7.8

Binary Coded Decimal (BCD) -- Even Parity

The contents of computer memory may be other than numerical information. It may be coded to cause specified characters to be printed on the line printer or typewriter. The vertical parity identifies these codes. Whereas binary frames have odd parity, BCD frames have even parity. Binary frames and BCD frames cannot be intermixed in a record. The codes used with tape are included in table 1-2-1.

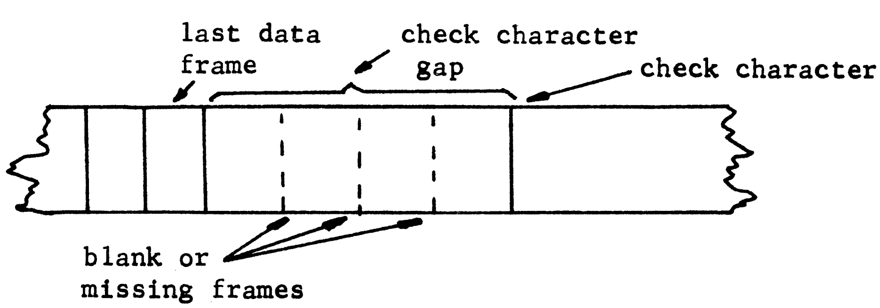


Figure 1-2-6.

CHECK CHARACTER (Longitudinal Parity)

A check character is written after every record. Following the writing of all frames of the output, and the record is complete, an additional frame is written which will cause each of the seven tracks to contain an even number of "1" bits. This check character is separated from the Record by the unrecorded space of three frames, called the Check Character Gap (See Figure 1-2-6).

The check character is prepared as the Write operation progresses and is ready to be recorded when the output is complete. During an input, the check character is being determined as the Read operation progresses. At the time the input operation ends, a comparison is made between the Check Character needed and the actual character read. The comparison, if not correct, will cause a parity Error to be detected.

The tape format with all format considerations and measurements is shown in Figure 1-2-7.

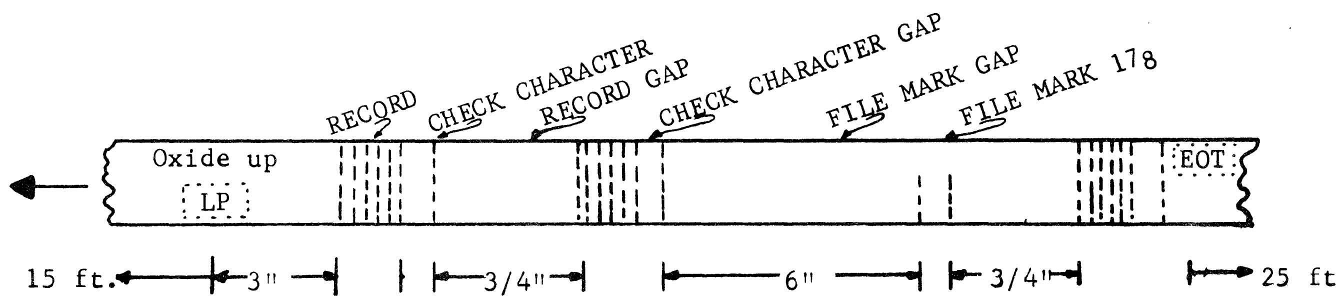


Figure 1-2-7

DENSITY

Density refers to the number of bits per track recorded on a linear inch of tape. There are three densities in common usage within the industry. These are Lo Density, 200 frames per inch; Hi Density, 556 frames per inch; and Super Density, 800 frames per inch.

Tape moves at a constant rate of speed during the Read or Write Operation. That speed, using the 606G Tape Transport as our example, will be 150 inches of tape per second. If it is desired that a record be written in Lo Density:

1. Thirty Thousands (30 K) frames will be written each second

$$150 \,\frac{\text{inches}}{\text{second}} \times 200 \,\frac{\text{frames}}{\text{inch}} = 30000 \,\frac{\text{frames}}{\text{second}}$$

556 83400

556 — 12 μsec @ 18/10.000 inch

2. A frame must be written every 33 microseconds

800 — 8.3 μsec @
1600 — 4.25 μsec @

$$\frac{1 \text{ frame}}{30\text{K} \,\frac{\text{frames}}{\text{second}}} = .000033 \text{ second} = 33 \text{ usec}$$

3. The distance between frames will be .005 inch

$$\frac{1 \text{ frame}}{200 \,\frac{\text{frames}}{\text{inch}}} = .005 \text{ inch}$$

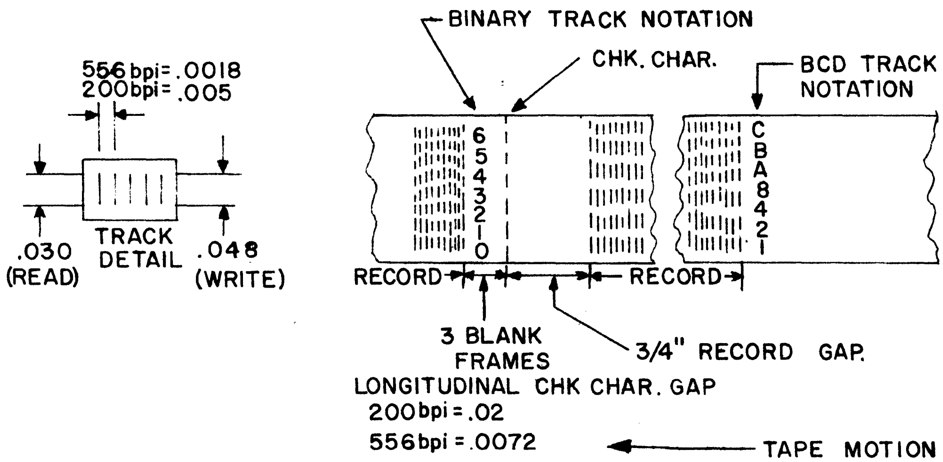
The rate of recording frames is closely controlled, usually by a crystal-controlled oscillator

$$f = \frac{1}{T} = \frac{1}{33} \text{ usec.} = 30{,}000 = 30 \text{ KC}$$

which must oscillate at 30 KC to record a frame every 33 usec.

The High Density recording will record a frame every 12 usec. Frames are .0018 inch apart and the oscillator needed to control the recording rate must operate at 83.4 KC.

Figure 1-2-10 illustrates these important characteristics.



NOTES:

1. Oxide side up on diagram, recording head on same side as oxide.
2. Write frequency 30 KC or 83.4 KC
3. Average steady state tape speed 150 ips ± 1%

Figure 1-2-10. Bit Assignments on Tape

SECTION II

THE CONTROL DATA 606 MAGNETIC TAPE TRANSPORT

CHAPTER I

GENERAL INFORMATION

606 Magnetic Tape Transport

CHAPTER I

GENERAL INFORMATION

INTRODUCTION

The CONTROL DATA 606 Magnetic Tape Transport is a high-speed input/output unit specifically designed to provide the high performance storage capabilities required by computer and data processing systems.

Information is stored with the 606 on magnetic tape in the form of magnetized spots or bits. Magnetic tape is an excellent storage medium because it provides the high density storage capability and rapid transfer rates required by modern data processing systems. The files, once stored on tape, can be used repeatedly as input information, thus eliminating the costly process of re-entering new input data. Although information recorded on tape is permanent, it may be erased and replaced by new information when desired.

The 606 may be used with computers in an on-line capacity, or with external equipment in an off-line processing system. When used on-line, for example, the operation of the 606 may be externally controlled by the CONTROL DATA® 160-A computer. In an off-line system, the 606 is under manual (local) control and is used with other peripheral equipments such as the CONTROL DATA® 166 Line Printer or the CONTROL DATA® 167 Card Reader. In both cases, the tape transport may function both as an input and an output device. The transport, in other words, accepts and stores information from the computer or peripheral equipment or sends data to the computer or peripheral equipment.

Transfer of data and the exchange of control information from computers or off-line equipments to magnetic tape is via a separate external control unit. The control unit provides the timing information necessary to buffer and control the flow of information into and out of the tape transport.

PHYSICAL DESCRIPTION

The location of major components in the 606 tape unit is shown in Figure 2-1-1. The tape unit is 72 inches high, 33 inches deep, 28 inches wide and weighs 1200 pounds.

Each tape unit includes self-contained, read/write electronics, control logic, and power supplies. Because the use of shared components has been eliminated, each 606 operates independently of other units in the system. In multiple-unit installations, for example, certain searching and positioning operations may be done simultaneously by two or more units. Any 606 may be removed from the line for testing and maintenance without affecting the operation of the remaining units.

A bank of switches and indicators on the front control panel allows the operator to monitor and manually control tape operations. A bank of switches and indicators on the rear maintenance panel provides complete operator control during test procedures.

The logic control section, mounted at the rear of the cabinet on a hinged chassis, controls the operation of the 606. The logic section consists of a number of circuits mounted on separate pluggable printed circuit cards.

Power input to the 606 is provided by 208v, three-phase, 15-ampere service line. All internal a-c and d-c voltages are developed and distributed by the power supply unit located at the lower rear of the cabinet.

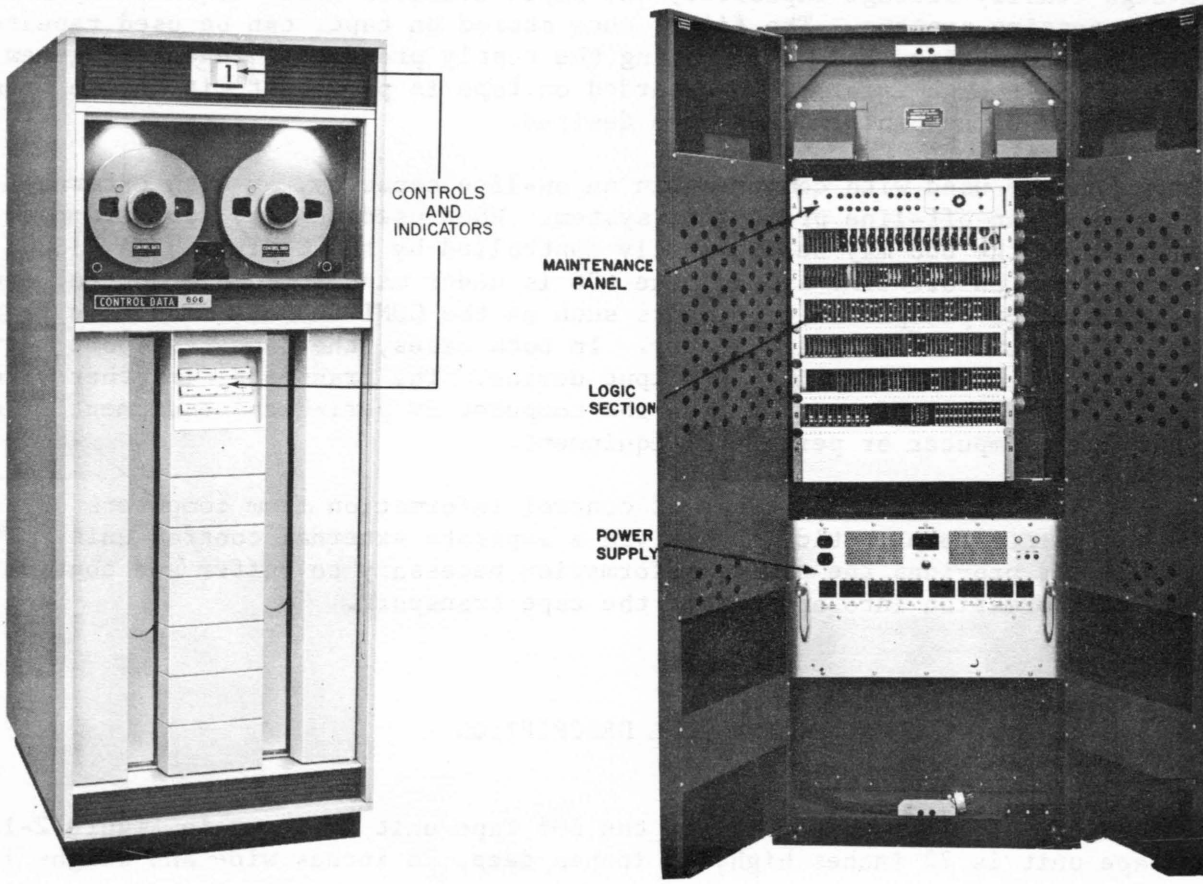


Figure 2-1-1. Tape Transport, Front and Rear View

THE CARE AND HANDLING OF MAGNETIC TAPE

As magnetic tape recording densities are increased to cope with modern data processing technologies, greater demands are being placed on magnetic tape performance. Using the finest magnetic tape with the highest quality tape transport equipment are requirements for providing maximum results in computer recording. However, other factors also affect the recording quality. Improper handling and storage of tapes can result in a variety of operational problems, any of which can result in signal distortion or complete dropout of recorded data. Since information may be written only 7/1000 of an inch from the tape's edge, simple but effective precautions must be taken to avoid data loss through damage.

TAPE HANDLING

Handling Precautions

Aside from the specific tape loading procedures found in the instruction manual for the tape transport being used, there are certain tape handling precautions which should always be observed.

High-speed tape winding operations cause air to be trapped between the tape layers and tape has a tendency to stack irregularly on the reel; that is, tape edges tend to protrude slightly, forming an irregular surface as viewed through the reel flange cutouts. This condition does not hamper tape performance but does require careful handling of the reel to avoid squeezing the reel flanges into contact with the tape edges. Handle tape reels at the central hub area where ever possible.

Damaged Tape From Improper Mounting

Improper seating of reels, improper threading of tape on transport during mounting, or improper handling of the tape reels can cause stretched, wrinkled, or creased edges. This "wavy edge" condition will prevent proper tape-to-head

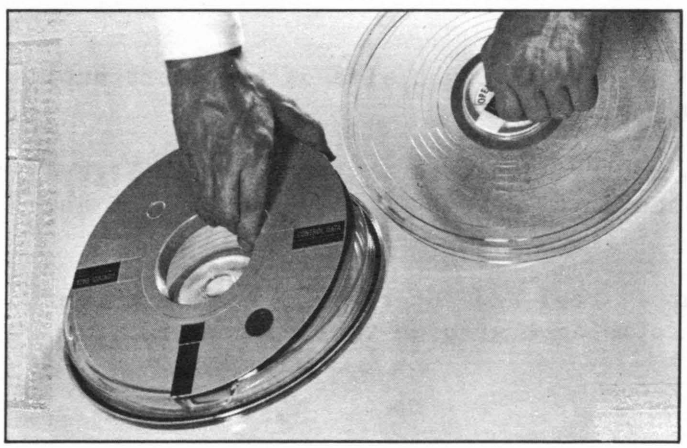


Figure 2-1-2

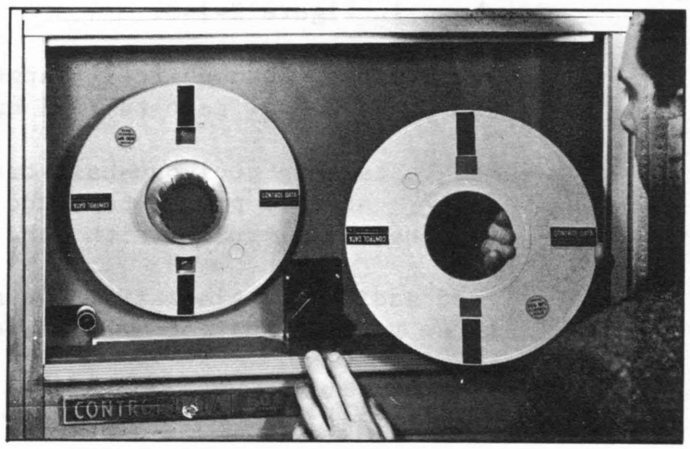


Figure 2-1-3

contact and will result in serious loss of signal amplitude (dropout) and resolution. The wrinkled edges present a stretched appearance and, normally, will not lie in close contact with a flat surface. Reel warpage or improper insertion of the file protect ring can also cause this form of tape edge damage. Other kinds of tape edge damage include nicked or creased edges from squeezed flanges.

Mounting The Tape Reel

The following procedures are recommended in mounting all tape reels:

- Turn transport hub knob in counterclockwise direction to allow acceptance of tape reel.

- Remove lock cover from plastic reel container. Place thumb on upper flange of reel at one of the three cutway areas on the container and place fingers in hub to remove reel (see Figure 2-1-2).

- Replace cover reel container and lock.

- As shown in Figure 2-1-3, a tape reel can be easily carried without any damage in handling. The reel is supported by the palm of the hand at the hub. Place the top of the thumb lightly on both edges of the reel and with very little pressure, outwardly separate the two flanges.

- Slip reel onto transport hub as shown in Figure 2-1-4. DO NOT force the reel onto the transport hub by grasping or pushing at the reel flanges; apply necessary pressure at the central (supported) portion of the reel.

- Seat reel squarely on transport hub, applying necessary pressure near the hub of plastic reel (see Figure 2-1-5).

- While holding reel in position, turn transport hub knob in a clockwise direction. DO NOT overtighten this locking device, but DO make certain reel is secure.

- Turn supply reel to provide slack as tape is threaded around idler wheels of tape load arms and under magnetic head. Extend tape over left reel as shown in Figure 2-1-6.

- Place finger through reel flange cut-out (at right side of transport hub) and press end of tape to reel hub.

- Rotate take-up reel one-half turn until a junction is formed as in Figure 2-1-7. At this point, tape end should lie perfectly flat on reel hub and in parallel alignment with hub.

- Feed additional slack from the supply reel and rotate take-up reel two or three revolutions (or until tape forms firm grip on take-up reel hub).

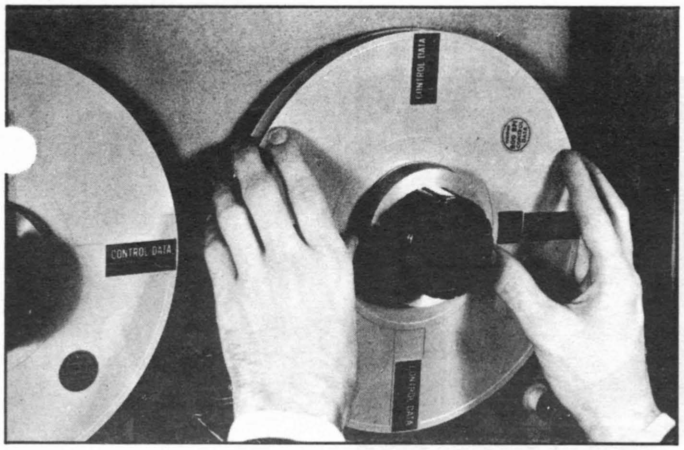


Figure 2-1-4

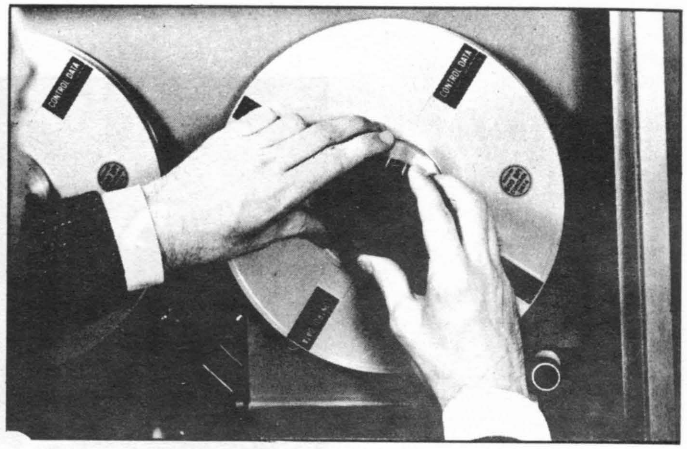


Figure 2-1-5

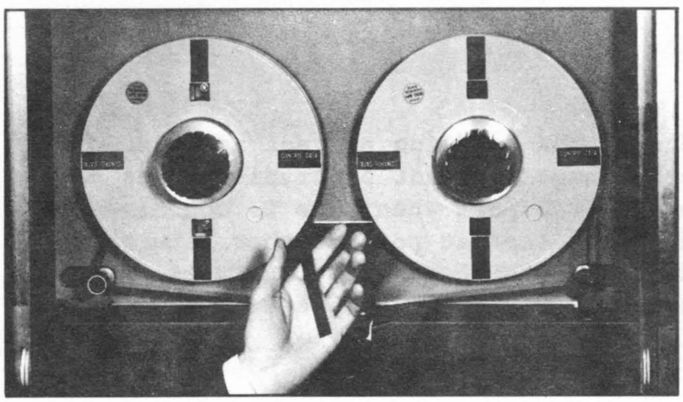


Figure 2-1-6

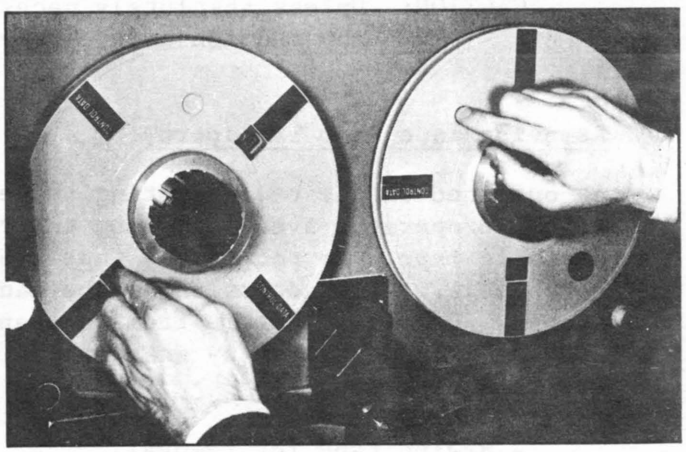


Figure 2-1-7

- Feed additional slack from supply reel such that tape falls away from left and right idler wheels as shown in Figure 2-1-8.

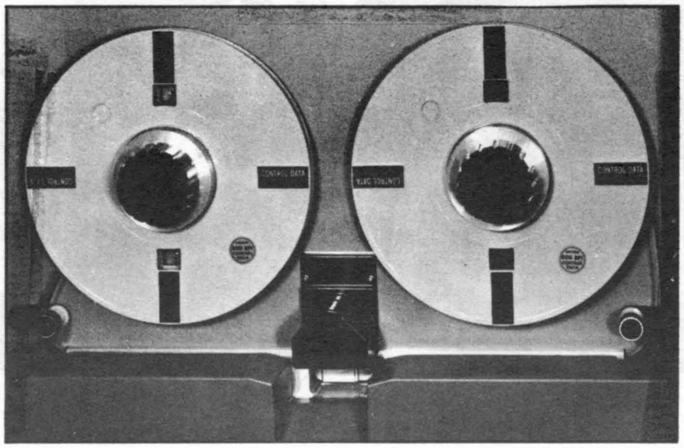


Figure 2-1-8

- Push down on left and right tape load arms. Tape should now be seated between the flanges of both idler wheels.

- Remove excess slack from tape before depressing the LOAD switch.

CAUTION: Unless absolutely necessary, do not perform a load operation on any section of tape beyond the load point marker.

Removing Tape From Transport

As outlined in the reel mounting procedures, the handling of tape reels requires that the operator avoid pressing the reel flanges against protruding edges of the magnetic tape. Do not remove tape from the transport when tape is contained on both reels. This necessitates the handling of tape at points other than the leader. Oil and moisture from the hands can contaminate oxide surfaces and handling will cause damage by snagging or catching of tape. Remove tape reels in the following manner:

- Rewind tape for removal.

- Turn transport hub knob in counterclockwise direction to unlock reel.

CAUTION: DO NOT place the fingers behind reel in an effort to "inch" reel from the transport hub. This usually results in permanent damage to tape edges.

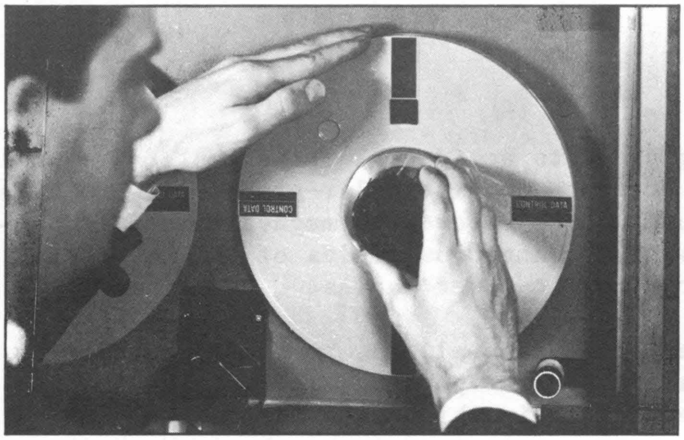


Figure 2-1-9

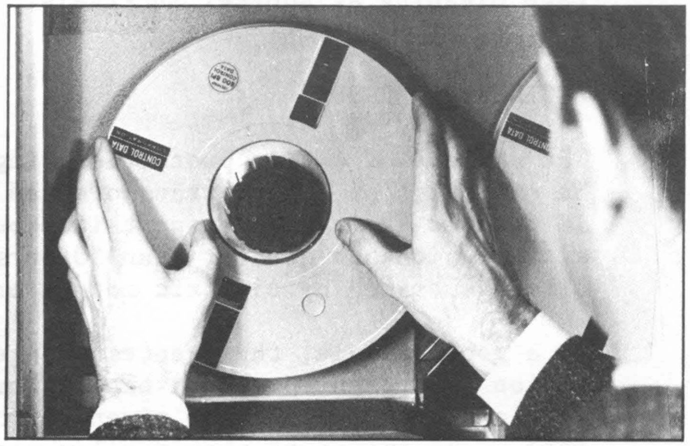


Figure 2-1-10

- Hold transport hub in stationary position. Place flat of hand across open edge of reel and gently rotate reel as shown in Figure 2-1-9.
- Place fingers behind OUTER flange of tape reel and remove reel from transport hub (see Figure 2-1-10).
- Handling tape reel at the central hub, place reel in plastic container and lock securely.

CONDITIONS AND PROCEDURES

HEAD MAINTENANCE

If trouble is experienced when using a tape transport, (i.e., failure to read or write satisfactorily), the magnetic heads should be inspected for accumulations of oxide or dust particles. It is recommended that the appropriate transport manual be referenced before applying cleaning agents to the heads. In the event cleaning is required, use a lint-free, non-abrasive cloth (or chamois), slightly damped with Freon TF*.

*Freon TF is a registered DuPont trademark.

It is recommended that tape heads, scrapers, and guides to be cleaned after every eight hours of transport operation (every four hours for 800 bit-per-inch operations) or following every ten full-reel passes, whichever occurs first. New tapes tend to leave more oxide residue than others; this condition may necessitate cleaning at shorter intervals.

ACCIDENTAL ERASURE

The absence of a file protection ring prevents accidental erasure of tapes while in operation on a tape transport and presents no particular problem. When a tape is removed from the transport it should not be exposed to magnetic field intensities which are greater than 50 oersteds. Dangerous fields of this type are often generated by electric motors or aircraft power cables.

As a general rule, the greatest danger of accidental erasure of recorded information is presented when a tape is mailed or transported. To avoid this loss, special attention must be given to the manner in which tape is packaged for shipment. The enclosure should allow clearance of 1½ to 2 inches between the tape reel and external walls of the container. Wood, paper, plastic or air may be used as the spacing agent. The materials also serve to pad the tape from mechanical shock.

TAPE SPLICES

Since the non-return-to-zero (NRZI) tape recording technique represents a "1" bit by a change in saturation polarity, any form of tape splice renders the entire reel undependable. Although both ends of the tape may be erased in the same magnetic sense after a splice has been made, continuity would not be present at the spliced edges. Hence, a condition representing bits of information would be detected during the read operation. The effect is similar to that of cutting a permanent magnet; separate poles are created at each point of separation.

STATIC CHARGES

High-speed tape operations tend to generate static charges through frictional contact of dissimilar materials. These charges are normally built up and retained by the polyester backing of some computer tapes. Resultant problems -- such as data misinterpretation caused by static drag effects, the attraction of dust, and excessive tape wear caused by sporadic tape motion -- have been eliminated in the design of all Control Data tape transports. The tape capstans, strippers, and brake ports are electrically grounded such that existing static charges are dissipated before adverse effects can hamper tape operation. As an added safeguard, the tape loop boxes are lined with a highly conductive material which eliminates the possibility of static build-up in these areas. The use of a heavy-duty tape will help dissipate static buildup by means of its low electrical coating resistivity.

CLEANING MAGNETIC TAPES

Control Data tape transports are equipped with tape cleaning devices which eliminate the need for manual dusting or wiping of magnetic tapes. These cleaning devices are designed to remove dust and foreign particles from the tape while being transported in either direction. Manual cleaning methods, involving the use of a line-free cloth and chemicals, are not recommended unless absolutely necessary to recover data.

REEL CONTAINERS

Plastic reel containers should never be allowed to lie open, free to collect dust which would eventually become deposited on tape. Always close and lock these cases when a tape reel is removed or replaced. If it becomes necessary to clean the reel container, the following methods may be applied: remove loose dust and lint by using a vacuum cleaner, wash container in a mild detergent solution, or clean with a lint-free cloth (or chamois) slightly dampened in Freon TF. Be sure the containers are completely dry before they are re-used.

STORAGE RECOMMENDATIONS

Recorded tapes should be stored at the same environmental temperature and humidity conditions as normally maintained in the machine room. If storage conditions vary to a large extent, tape stresses should be permitted to stabilize in the machine room environment for a period which is equal to the time out of the controlled area, or a maximum period of 24 hours before being used. Normal machine room temperatures range between 60° and 80° Fahrenheit, and relative humidity levels of 40 to 60%. The environmental limits for long term storage are 40° to 90° Fahrenheit and 20% to 80% relative humidity (with wet bulb not to exceed 80° Fahrenheit). Tape will not fail to meet specifications within these limits if it is preconditioned in the operating environment before being used.

If tape has been exposed to environments outside of this range, allow 24 hours for stabilization at room temperature, then wind the tape back and forth throughout its entire length at low speed. The winding process allows remaining tensions and stress to be relieved, and should be performed before any attempt is made to recover recorded data.

Ideally, the greatest protection against possible fire damage is to provide complete isolation of the tape storage area. Where this is impossible, the tape storage shelves should not be adjacent to, or supported by, combustible walls, and all combustible materials should be removed from the immediate vicinity. If fire-fighting measures must be taken in an unisolated storage area, the use of CO_2 is recommended.

Tapes should always be stored on racks or shelves which provide vertical support for all reels while all tapes should be stored in closed containers (plastic or metal) which support the reel at the central hub.

MACHINE ROOM ENVIRONMENT

Cleanliness of the machine room is of primary importance in maintaining satisfactory tape operation. Ideally, conditions set down by the Air Force Class 1 clean room specifications would insure the highest degree of tape performance. Although it is often impossible to obtain these immaculate conditions, certain considerations should be given to the basic environment and routine cleaning procedures.

Materials used in the walls and ceiling of the machine room should be such that they will not cause dust or flaked paint to contaminate room air. The machine room should be vacuumed or wet mopped each day, with special attention to proper filtering of the vacuum cleaner exhaust. Never dry dust, dry mop, or sweep the area; this only succeeds in increasing the dust content of room air.

Airborne particles, dust, or dirt can reduce or prevent the proper physical contact which must exist between the oxide surface of the tape and the magnetic heads. A condition which causes as little as 0.0005 inch separation between the head and tape will result in signal reduction of approximately 60 percent as well as significant resolution loss. Also, the abrasive action of dust causes unnecessary head wear and shortens the effective life of the magnetic tape. One or more of the following machine room precautions are often overlooked:

- Aerosols should never be used in the machine room. The oily, dust-collecting moisture settles and eventually finds its way to tape surfaces.
- Smoking should not be permitted in the area. Live coals cause permanent damage to tape surface, and ash particles wound into tape layers cause information dropouts.
- Special attention should be given to the room air-conditioning filters. Fiberglass filters often permit the passage of fine silts, or cause tiny particles of fiberglass to be deposited on magnetic tapes.

(The following is a reprint from "Technical Manual--Standard Functional Criteria for Design and Operation of Clean Rooms", T. O. 00-25-203, 1 March, 1961.)

Special Considerations

1. Within the limitations imposed by use of standard furniture and fixtures, every consideration should be given to installation and arrangement that will keep floors, corners, aisles,aand workbenches clear and uncluttered so as to facilitate easy, frequent, and thorough cleaning of all these areas.
2. A central vacuum cleaning system capable of wet or dry pickup should be installed with convenient outlets for servicing all work area, furniture, floors, and benches. It should be an industrial type system of sufficient power and capacity to service the entire clean room, and with provisions for emptying the dust tank that will not contaminate the clean room or the intake air.

Only flexible plastic vacuum hoses will be used.

3. Since the major source of dirt brought into the clean room will be shoes, it is most important to provide adequate facilities for scraping, brushing, and wiping all dirt off shoes of all personnel before they enter the clean room. The specific requirements for cleaning shoes will vary according to local conditions and the workload.

4. If the parts cleanup area generates volatile vapors, then fully filtered air must be provided with 100 percent exhaust to the outside.

REFERENCE CHART 1

TAPE CONDITION	POSSIBLE CAUSE
Creases or indentions in tape surfaces.	Wrinkled reflective markers. Tape not started flat on take-up reel hub. Improper handling of tape. Dirty take-up reel hub. Tape end allowed to drop on floor.
Creased, nicked or damaged tape edges.	Reel held by flanges when mounting or removing from transport; flanges squeezed or pressed against tape edges. Fingers nicking or pressing against tape in cut-out areas of reel. Warped reel. Tape reel has been dropped. Tape unloaded and handled when tape is not completely rewound to supply reel or take-up reel. Reel not seated properly on transport hub. Transport not adjusted properly.
Accumulation of foreign material on tape surfaces.	Tape transport not being cleaned properly. Tape not being replaced in closed containers when not in use. Dust or dirt in tape containers. Residue left on reels when labels are removed. Eraser used in changing information contained on reel labels. Fingerprints on tape surfaces. Smoking or eating in machine room. Unnecessary traffic in machine room. Improper filtering of machine room air. Improper or insufficient cleaning of machine room.
Wavy tape edge or stretched appearance along edges.	Reel hubs or idler wheels improperly adjusted. Reel not mounted squarely on transport hubs. Warped reel. Improper insertion of file protect ring, preventing proper reel mounting. Improper handling of tape when mounting or removing reel from transport.
Loss of recorded data.	Accumulation of foreign material on tape surface. Creased or damaged tape. Nicked tape edges. Wavy or stretched edges. Accidental erasure.

REFERENCE CHART 2

DO keep reels and containers clean.	DON'T allow any portion of tape to contact floor.
DO use care in placing reflective markers on tape.	DON'T lay tape on dirty surface when applying reflective markers.
DO start tape flat on take-up reel.	DON'T allow tape to fold or protrude through reel flange cut-out when starting on take-up reel.
DO pick up tape reels by holding reel at hub and outer edge of reel flange.	DON'T squeeze tape reel flanges when picking up or holding reel.
DO avoid contact with tape through cut-out areas of reel flanges.	DON'T nick or damage tape edges at reel flange cut-outs.
DO inspect tape and reel closely if dropped.	DON'T handle tape carelessly. DON'T unload and handle tape when not completely wound on reel.
DO seat reel squarely on transport hub when mounting.	DON'T mount reel on transport hub in cocked manner.
DO keep transport clean, especially heads and tape transport mechanism.	
DO keep tape in a clean container when not on transport.	DON'T allow tape to lie uncovered or exposed to contamination.
DO use labels for identification of reels which will not leave residue when removed.	DON'T use eraser in changing identification written on reel labels.
DO maintain "clean room" conditions at all times.	DON'T smoke in machine room. DON'T eat in machine room. DON'T allow unnecessary traffic in the area. DON'T allow contaminated objects in machine room.
DO clean machine room with wet mop and/or vacuum daily.	DON'T dry mop, sweep, or use dust cloths in machine room.

CHAPTER II

FUNCTIONAL AND PHYSICAL CAPABILITIES

CHAPTER II

FUNCTIONAL AND PHYSICAL CAPABILITIES

FUNCTIONAL DESCRIPTION

TAPE MOTION

During a read or write operation, tape is moved from the supply reel, past the read/write heads, to the tape-up reel (Figure 2-2-1). Tape motion is provided by two fluted capstans which rotate continuously in opposite directions. Tape is drawn against the drive capstan by vacuum and floated over the non-driving capstan by air pressure. If the tape is moving from the supply reel to take-up reel (forward motion), the left capstan drives the tape. If tape motion is in the opposite (reverse) direction, the right capstan provides the drive.

Tape motion is quickly and smoothly stopped by means of a pneumatic brake port. Tape is drawn to and firmly held against the brake port by means of a vacuum. Because pressure is applied to both capstans during this period, neither capstan contacts (drives) the tape.

READ/WRITE HEADS

The head assembly consists of individual read and write heads, an erase head, tape cleaners, and pneumatic pad. Each of the seven read/write heads used in the tape transport has two magnetic gaps. One gap is used for writing; the other, for reading. The gaps are arranged so that during a write operation, the tape first passes under the write gap to record the data and then under the read gap to check the writing. This allows each line of information to be examined and verified immediately after it is written on the tape. Thus, if any discrepancy occurs during the write operation, it is immediately detected at the read head.

The tape cleaners and erase head clean the tape prior to a read or write operation. The broad-band erase head removes any information recorded on the tape before new information is recorded by the write heads. The two tape cleaners, located on either side of the heads, pneumatically remove foreign particles from the tape surface during a read or write operation.

A pneumatic pad maintains precise contact pressure between the tape and the head gaps. This contact pressure is provided by means of air pressure, which minimizes head and tape wear by blowing the tape against the heads.

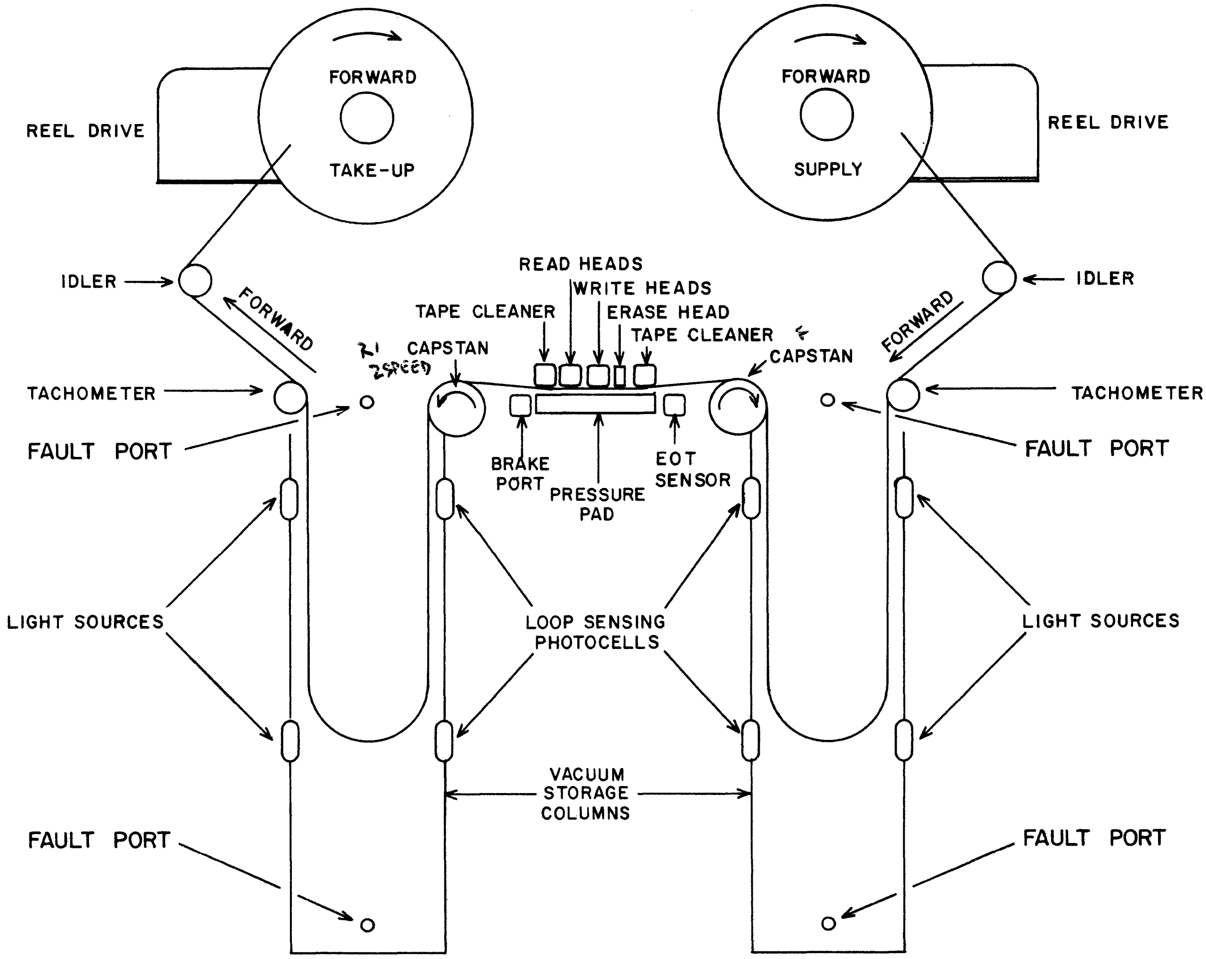


Figure 2-2-1. Tape Path

VACUUM BUFFER COLUMNS

The tape transport can accelerate tape to high speed within 2.75 milliseconds. Conversely, tape motion is completely stopped within 1.75 milliseconds. The tape transport uses vacuum loops to reduce to a minimum the tape mass that must be accelerated during the 2.75 milliseconds period. These loops separate the heavy tape reels from the portion of tape under the heads.

The two loops form tape reservoirs for the capstan drive system. During the first few milliseconds of acceleration, the actuated capstan pulls tape from one loop and places it in the second loop. As tape is drawn from one column, it is replaced from the reel above it. As tape is fed into the opposite column, the associated reel takes up the slack. The heavy tape reels are therefore given more time to accelerate and act to increase or reduce the amount of tape in the vacuum columns. In other words, tape loops buffer the heavy reels out of the high acceleration capstan drive system. This minimizes the inertia in the high acceleration system as the capstans need only accelerate the mass of a few feet of tape.

The vacuum columns also maintain tension throughout the system. Each loop fits snugly into a chamber and divides the chamber into two parts. The bottom portion of the column is under reduced pressure. The upper part is at atmospheric pressure which pushes the loop down, providing a small amount of tension on the loop.

REEL DRIVE AND SERVO CONTROL

The reel drive controls the position of the tape loops in the vacuum columns. A servo system between each loop and tape drive, positions the tape reels by responding to signals from the vacuum column photosense indicators. If the tape loop in a column is too long, the photosense indicators signal the reel drive to take up tape. If the loop is too short, the indicators signal the reel drive to deliver tape.

Each reel servo circuit contains a tachometer, reel motor and magnetic brake, a reel drive chassis, and two photocell sensing stations (Figures 2-2-2 and 2-2-3). These components either feed signals to, or are controlled by, the photocell circuits contained in the logic chassis.

The tachometer generates an a-c signal which is directly proportional to the tape speed as it passes into, or out of, the loop box columns. The generated signal controls the maximum speed of the associated reel motor, reducing the motor speed when the magnetic tape speed exceeds capstan speed by approximately ten inches per second. Both tachometers are disconnected from the servo circuits when the high speed rewind operation is being performed.

Upper and lower photocell stations, located in each loop box, monitor the tape loop positions as they vary between minimum and maximum length. When a tape loop is high, permitting both photocell stations within that column to conduct, the servo circuit increases the speed of the associated reel motor and the tape loop assumes a lower position in the loop box (when viewed from the supply side of the tape transport). As the tape loop extends below the upper photocell station, excitor lamp illumination no longer reaches that photocell. The "on" condition at the lower photocell station and the "off" condition at the upper photocell station cause the associated reel motor to be braked. Hence, the reel servo circuits tend to maintain the proper tape loop position by alternate drive/brake action.

If the other extreme condition occurs; that is, the tape loop extends into the loop box to a point where neither of the photocells is lighted, servo circuits remove tape from the loop box column by driving the associated reel motor as required to remove the tape.

Circuits contained in the reel drive chassis of each reel control system provide the necessary operating current and relay switching functions required by the reel motor and magnetic brake units. Control signals determine the direction of reel drive, start/stop, and initiate magnetic brake on/off. The control signals are received from the servo drive logic circuits.

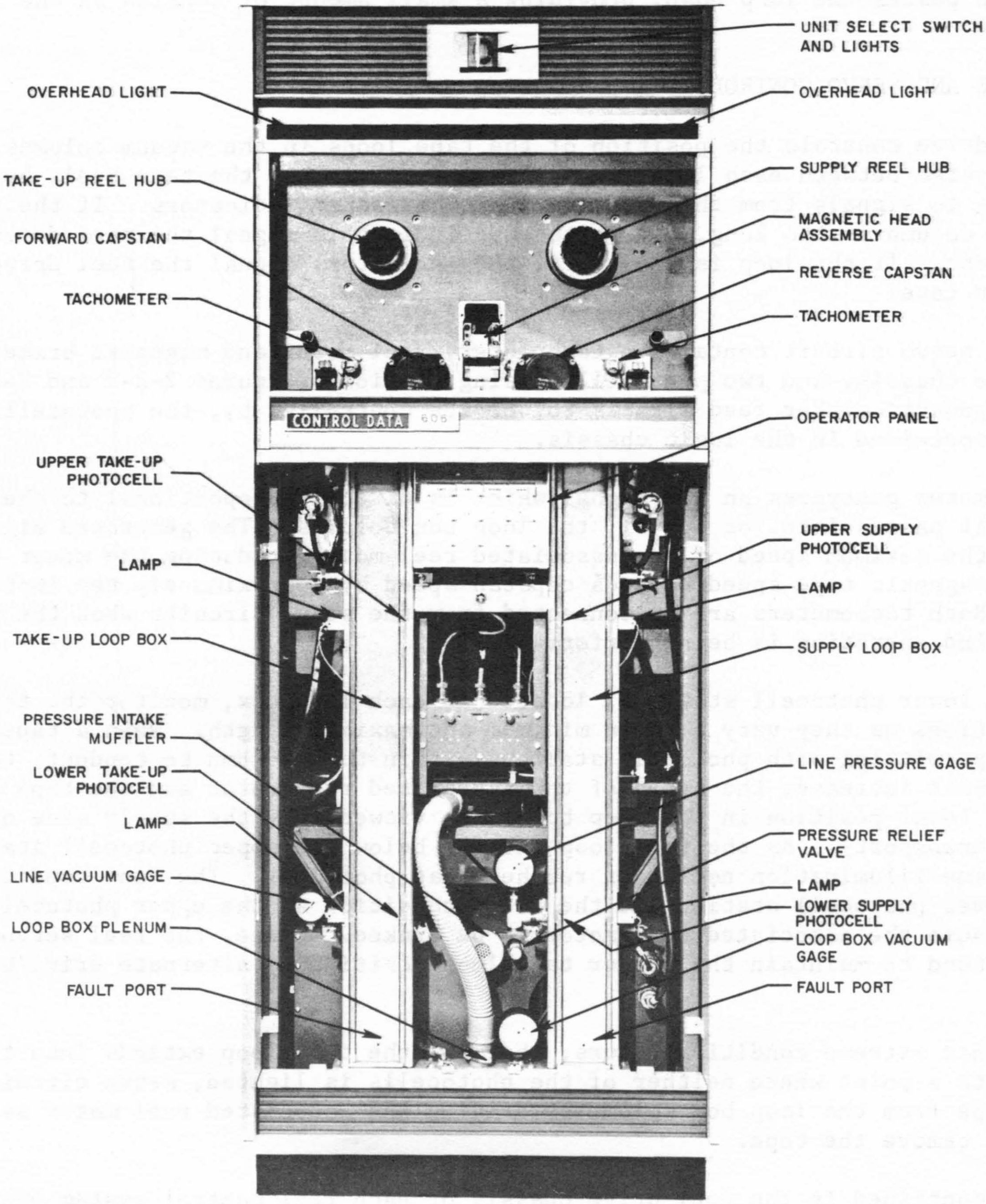


Figure 2-2-2. Tape Transport, Front View

Reel motors are 115 vdc $\frac{1}{4}$-hp, composite shunt-wound units with 40-volt field windings. Motor bearings are sealed at the factory and no lubrication is required.

Magnetic particle brakes are mounted at the rear of each reel motor. The brake assembly consists of a housing and a rotor which is keyed to the reel shaft. A coil is embedded in the housing and a mixture of magnetic powder is enclosed between the rotor and housing. When current is passed through the coil, a magnetic flux is produced. The rotor and housing are essentially bonded together by chains of magnetic particles formed along the lines of magnetic flux providing the braking action.

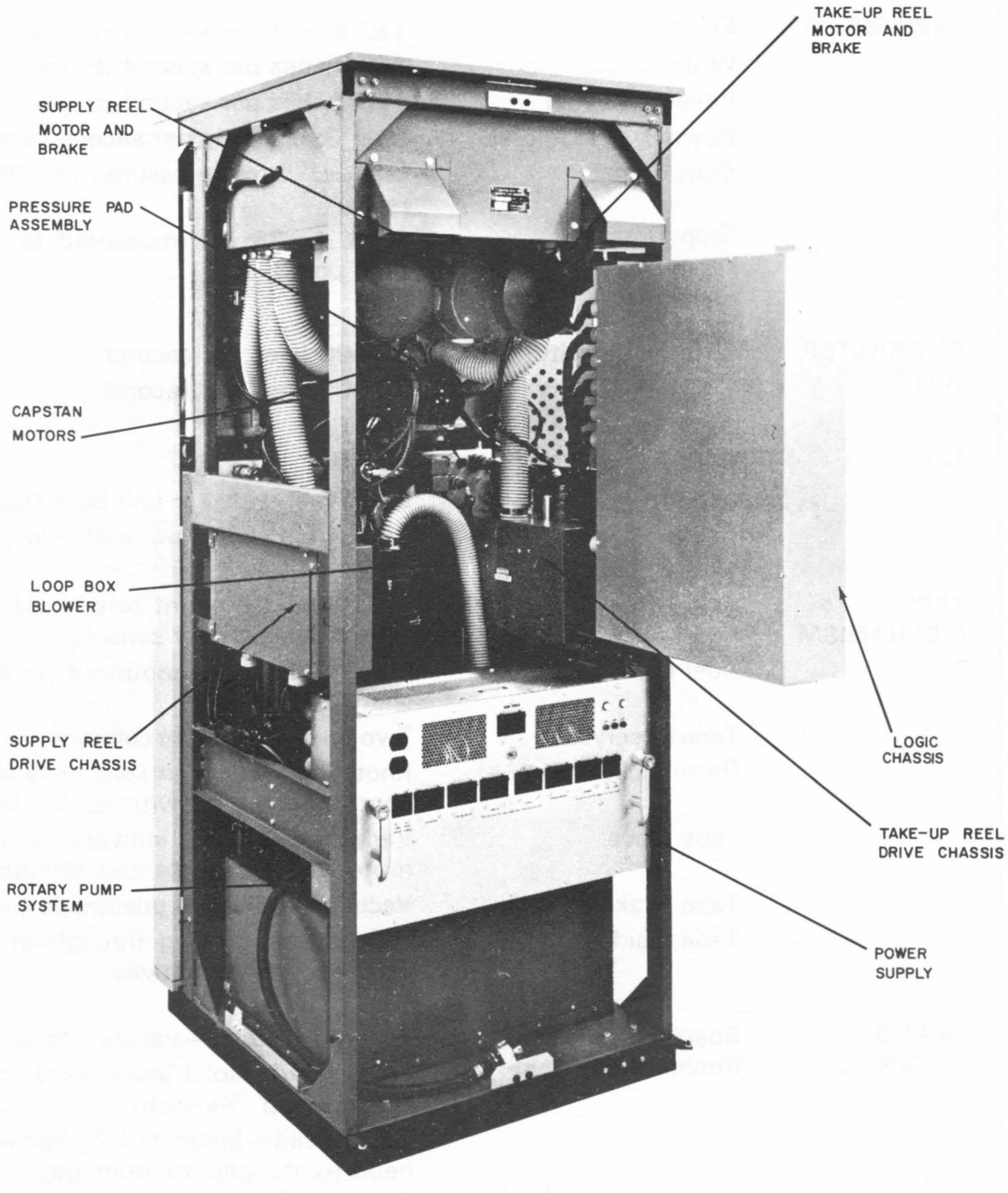


Figure 2-2-3. Tape Transport, Rear View

TABLE 2-2-1. DETAILED SPECIFICATIONS

RECORDING FORMAT	Method	NRZI (non-return-to-zero, change-on-ones)
	Seven Track Recording	Data 6 bits, parity 1 bit, self clocking
	Inter-Record Gap	¾ inch
	Tape Markers	End of tape and load point reflective spot
	Recording Density	556 frames per inch or 200 frames per inch, selectable
	Compatibility	Compatible with CDC 603, 606, 607, 1607, 163, 164 and IBM 729 I-VI, 727, 7330 Units
TAPE SPEED	Read	150 inches per second ± 1%
	Write	150 inches per second ± 1%
	Reverse Search	150 inches per second ± 1%
	Rewind and Unload	Over 350 inches per second average
	Start Time	2.5 ± .5 ms (measured to 90% amplitude point)
	Stop Time	1.75 ± .25 ms (measured to 10% amplitude point)
CHARACTER RATE	556 bpi Density	83,400 lines per second
	200 bpi Density	30,000 lines per second
TAPE	Width	½ inch
	Length	**2400 feet with 1½-mil base tape**
	Reels	10½-inch IBM hub with file protect ring
TAPE MECHANISM	Reel Drive	Individual d-c shunt torque motors, digital control by reservoir sensors
	Reel Brakes	Electromagnetic, mounted on drive motor shaft
	Tape Reservoir	Two 43-inch vacuum columns
	Reservoir Sensors	Photoelectric, silicon solar cells for reel drive control; vacuum switches for fault sensing
	Tape Drive	Vacuum capstans, individually synchronous motor-driven; voice coil pneumatic valves
	Tape Brake	Vacuum—voice coil pneumatic valve actuated
	Tape Guides	Full channel guiding throughout tape reservoirs and capstan drives
HEADS—PHYSICAL	Spacing (forward direction)	Forward Cleaner—vacuum controlled Erase Head—solid broad band dc (erase gap to write gap: 7/16-inch) Write Head—laminated 7-channel flat-metal head (write gap to read gap: 0.300 inch)

TABLE 2-2-1. DETAILED SPECIFICATIONS (continued)

HEADS—PHYSICAL	Spacing (forward direction)	Read Head—laminated 7-channel flat-metal head	
		Reverse Cleaner—vacuum controlled	
	Write Gap	0.00100 inch	
	Read Gap	0.00025 inch	
	Write Gap Width	0.048 inch (each track)	
	Read Gap Width	0.030 inch (each track)	
	Erase Gap Width	9/16 inch (full tape width)	
	Contact Recording	Maintained by jets of air on opposite side of tape	
	Head Gap Alignment	Mechanical gap parallel within 100 micro-inches	
	Static Skew	Overall correction by mechanical adjustment of read/write head mounting—detail correction by adjustable electronic delays on each read channel and each write channel	
FRONT CONTROL PANEL	Operator Controls With Indicators	Power	Density Lo Density Hi
		Forward	Ready
		Reverse	Clear
		Unload	Unit Number Selector
		Load	Rewind
	Operation Indicators Only	Read	Unit Select Status (2)
		Write	File Protect
PHYSICAL	Size and Weight	Height—72 inches	Width—28 inches
		Depth—33 inches	Weight—1200 pounds
	Construction	Steel frame on casters with removable front and side panels and hinged rear doors.	
	Environment	60° to 90° F. Temp., 30% to 80% relative humidity, dust free (typical computer room environment)	

TABLE 2-2-1. DETAILED SPECIFICATIONS (continued)

Output
Connector No. J208

Pin	Service
A	2^0 Write
B	2^1 Write
C	2^2 Write
D	2^3 Write
E	2^4 Write
F	2^5 Write
H	Parity Write
J	Write Sprocket
K	Address 6
L	Address 7
M	Forward
N	Reverse
P	Stop on File Mark
R	Select High Density
S	Select Low Density
T	Write Select
U	Read Select
V	Master Clear
W	Rewind Unload
X	Rewind
Y	Address 5
Z	Unit Select Light No. 1
a	Unit Select Light No. 2
b	Ground

Input
Connector No. J209

Pin	Service
A	2^0 Read
B	2^1 Read
C	2^2 Read
D	2^3 Read
E	2^4 Read
F	2^5 Read
H	Parity Read
J	Read Sprocket
K	Write Ready
L	Address 4
M	End of Operation
N	File Mark
P	Address 0
R	Address 1
S	Address 2
T	Address 3
U	Busy
V	High Density Selected
W	Load Point
X	End of Tape
Y	Ready
Z	
a	
b	Ground

APPLICATION OF POWER

To initially energize the tape unit:

1. Open doors at back of cabinet.
2. Push the Main Power circuit breaker (on power supply) to the up position.
3. Push the remaining circuit breakers (on power supply) to the up position.
4. Hold the Power switch on the maintenance panel in the on position for about two seconds, then release.
5. The Power indicator on the front panel should turn on. If not, repeat the procedure.
6. Close the back doors.

The Power switch on the front operator's panel is used only to remove power from the unit. Once this switch is pushed, the above procedure must be repeated in order to apply power to the unit.

TAPE LOAD PROCEDURE

1. Slide front door down to lowest position (Figure 2-2-4).

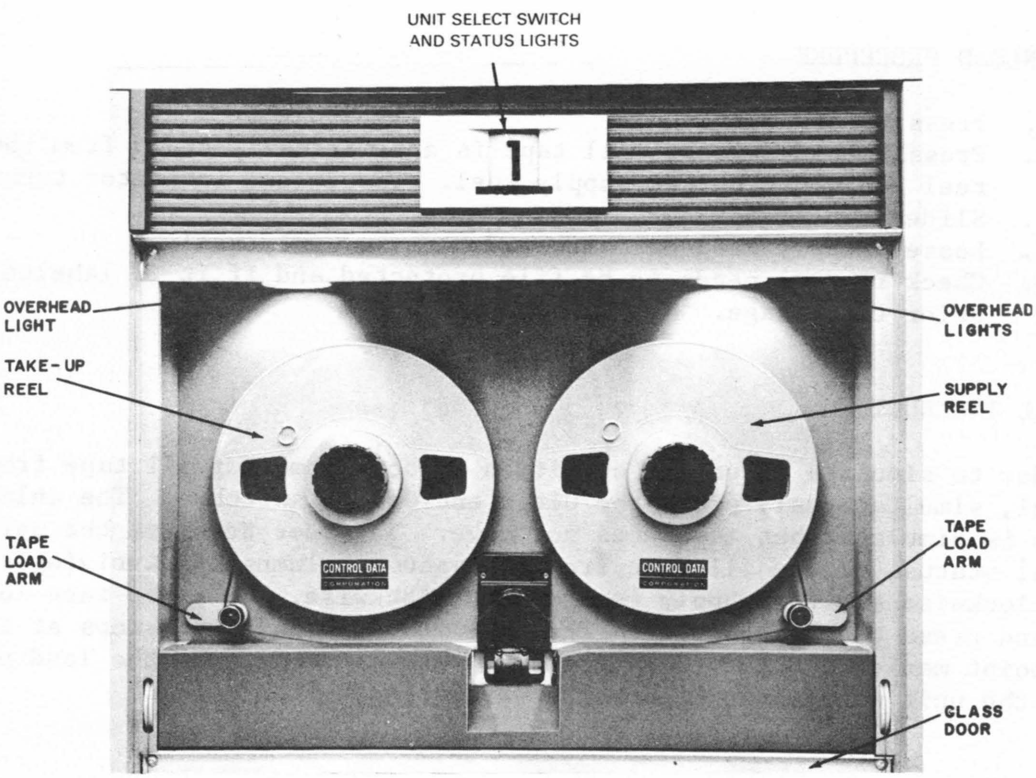


Figure 2-2-4. Tape Load and Unload Mechanics

2. Check that supply reel has been file protected as necessary.
3. Mount reel on supply reel hub and tighten knob. Caution: for proper alignment, push reel firmly against hub stop before tightening knob.
4. Make sure tape load arms are in up position.
5. Pull sufficient tape from supply reel to reach take-up reel. Thread tape on the outside of the supply tape load arm, over the head assembly, around the outside of the take up load arm, and over the top of the take-up reel. Release tape and spin the take-up reel hub two or three times.
6. Slide tape under head assembly.
7. Snap tape load arms down.
8. Set Unit Select switch to one of ten positions (0-7 or two standby) to assign a logical program selection number.
9. Press Load switch. Tape drops in columns, moves forward, and stops on Load point marker. The Load indicator turns on. If tape continues moving forward for more than 3 or 4 seconds, it indicates either no load point marker was placed on the tape or the operator manually wound the marker onto the take-up reel during step 5. Press Clear and Reverse pushbutton. Tape moves in reverse to Load Point.
10. If the unit is to be externally controlled, press the Ready switch. It is to be manually operated and the Ready switch has been pushed, press the Clear switch.
11. Push up door.

If the supply reel contains a file protection ring, the overhead lights should be on, indicating that a write operation may be performed.

TAPE UNLOAD PROCEDURE

1. Press Clear Switch
2. Press Unload switch. All tape is automatically drawn from the take-up reel and wound on the supply reel. The Unload indicator turns on.
3. Slide down front door.
4. Loosen supply reel hub knob and remove supply reel.
5. Check if reel needs to be file protected and if it is labeled adequately prior to storage.

SPECIAL INSTRUCTION

In order to simulate an unload condition without removing all tape from the take-up reel, simultaneously press the Clear and Unload switches. The unload condition is simulated but tape does not move. In order to place the unit in operational status, remove all tape from the vacuum columns by revolving the take-up reel clockwise and the supply reel counterclockwise. Snap the tape load arms down and press the Load switch. The tape moves forward and stops at the nearest load point marker and the Load indicator turns on. If past the load point marker, clear the unit when motion starts forward.

If all tape is unwound from the supply reel:

1. Snap tape load arms up, if necessary.
2. Guide tape around the tape arms, over the head assembly, and wrap approximately ten turns around the supply reel.
3. Slide tape under head assembly.
4. Press the Load switch.
5. As soon as the Forward light turns on, press the Clear switch and then the Reverse switch. The tape rewinds to the nearest load point marker.

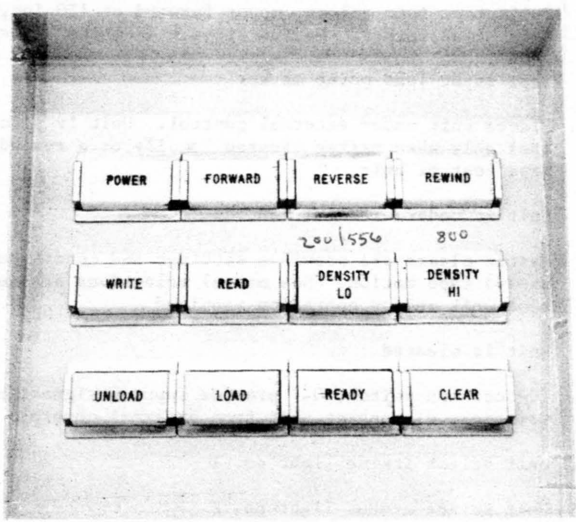
The following information is applicable when a number of load point or end of tape markers are used on a single tape.

To move forward from a reflective marker and stop at nearest end of tape marker, press the Forward switch.
To move forward off a reflective marker and stop at nearest load point or end of tape marker, press the Forward switch. Load indicator lights if motion stops at load point marker.
To reverse from a reflective marker and stop at nearest load point marker, press the Reverse switch.

Tape motion may be stopped at any time by pressing the Clear switch. An unload operation may be performed by pressing the Unload switch.

MANUAL OPERATION

The manual controls and indicators for operating each tape unit are mounted on a panel located below the front door of the unit (Figure 2-2-5).



604 DRIVES
200/556 | 800

Figure 2-2-5. Operation Control Panel

The functions of the controls are described in table 2-2-2.

TABLE 2-2-2. MANUAL CONTROLS AND INDICATORS

NAME		FUNCTION
POWER	S*	Removes power from all components and power supplies
	I**	Power is available to components and power supplies
FORWARD	S	Moves tape from right to left at 150 ips. Motion stops when end of tape marker is sensed
	I	Tape is moving forward at 150 ips
REVERSE	S	Moves tape from left to right at 150 ips. Motion stops when load point marker is sensed 75 ips
will stop at LD.PT.		
	I	Tape is moving in reverse direction at 150 ips
REWIND	S	Rewinds tape at high speed (over 320 ips average). Motion stops when load point marker is sensed
	I	Tape is moving in reverse direction at high speed
WRITE	I	Write operation is in progress
READ	I	Read operation is in progress (not on during read while write operation)
DENSITY HI	S	Selects information transfer rate of 556 bpi
	I	High density mode selected
DENSITY LO	S	Selects information transfer rate of 200 bpi
	I	Low density mode selected
UNLOAD	S	Moves tape in reverse to unload position (all tape on supply reel). Tape load procedure must be performed to resume operation
	I	Tape unit is in unload status
LOAD	S	Pulls tape into column, moves forward at 150 ips, and searches for load point marker. Motion stops when marker is sensed
	I	Tape is at load point marker
READY	S	Places unit under external control. Unit is placed under manual control only when master cleared locally or a rewind unload selected by tape control unit
	I	Unit is under external control
CLEAR	S	Master clears all previous settings and conditions. Stops (immediately) tape motion. New manual selections are necessary to reselect tape unit and/or operation required
	I	Unit is cleared
UNIT SELECT	S	10-position switch; 0-7 provide input designation while two standby positions disconnect unit from external control
	I (White)	Unit select status light no. 1
	I (Red)	Unit select status light no. 2
OVERHEAD LIGHTS	I	File protection ring is on reel (unit can write) and tape unit is not in the unload position

*Switch
**Indicator

Ready CLR
LOAD
READY

CLR
UNLOAD

THE PNEUMATIC SYSTEM

The vacuum and pressure systems (Figure 2-2-6) used in the tape transport provide complete pneumatic control of tape motion. In general, the vacuum and pressure systems may be divided into two independent pneumatic subsections: loop box system and rotary pump system. The first system provides a high volume of low vacuum to operate the loop box storage columns. The rotary system, on the other hand, provides a relatively low volume of high pressure and vacuum to operate the tape cleaners, tape brake, pressure pad, and capstans. The distribution of pressure and vacuum from the rotary system is detailed in the manifold and valve panel description.

LOOP BOX PNEUMATIC SYSTEM

The loop box blower system provides a vacuum to a plenum chamber through a supply hose. The plenum chamber, in turn, supplies vacuum to both the take-up and supply vacuum columns (as required). The loop box vacuum gage provides an indication of the amount of vacuum present in the system at any given time.

The primary function of this system is to apply a difference in air pressure to each side of the magnetic tape loop as it hangs in the loop box. Hence the blower exerts a constant suction force on the lower side of the tape loop which assists in the initial tape load operation and in handling tape slack during normal operation.

The loop box blower is powered by a 208-volt, 3-phase motor. Armature bearings are lubricated and sealed by the manufacturer and require no maintenance or lubrication.

ROTARY PUMP SYSTEM

The pneumatic system, shown in Figure 2-2-7 and 2-2-8, provides a relatively low volume of high pressure and vacuum to operate the tape cleaners, tape brake or pressure pad assembly, and capstans. Figure 2-2-9 shows, in schematic form, the distribution of pressure and vacuum to various components.

The system employs a dual rotary pump consisting of two separate pump assemblies within a common exterior housing. A common axis shaft serves both units and is belt-coupled to a drive motor. A cross-sectional view of a single pump unit is illustrated in Figure 2-2-10. The physical configuration includes the outer housing with intake and exhaust ports, and a slotted rotor containing vane inserts. Except for the intake and exhaust ports provided in the upper area of the housing, the inner housing consists of a smooth, polished surface. The central rotor is bearing mounted and located off center, toward the upper side of the housing. Four vanes ride freely in the slots provided on the cylindrical rotor. When the drive motor is energized, centrifugal force causes the vanes to move outward in a radial direction and follow the inner surface of the housing.

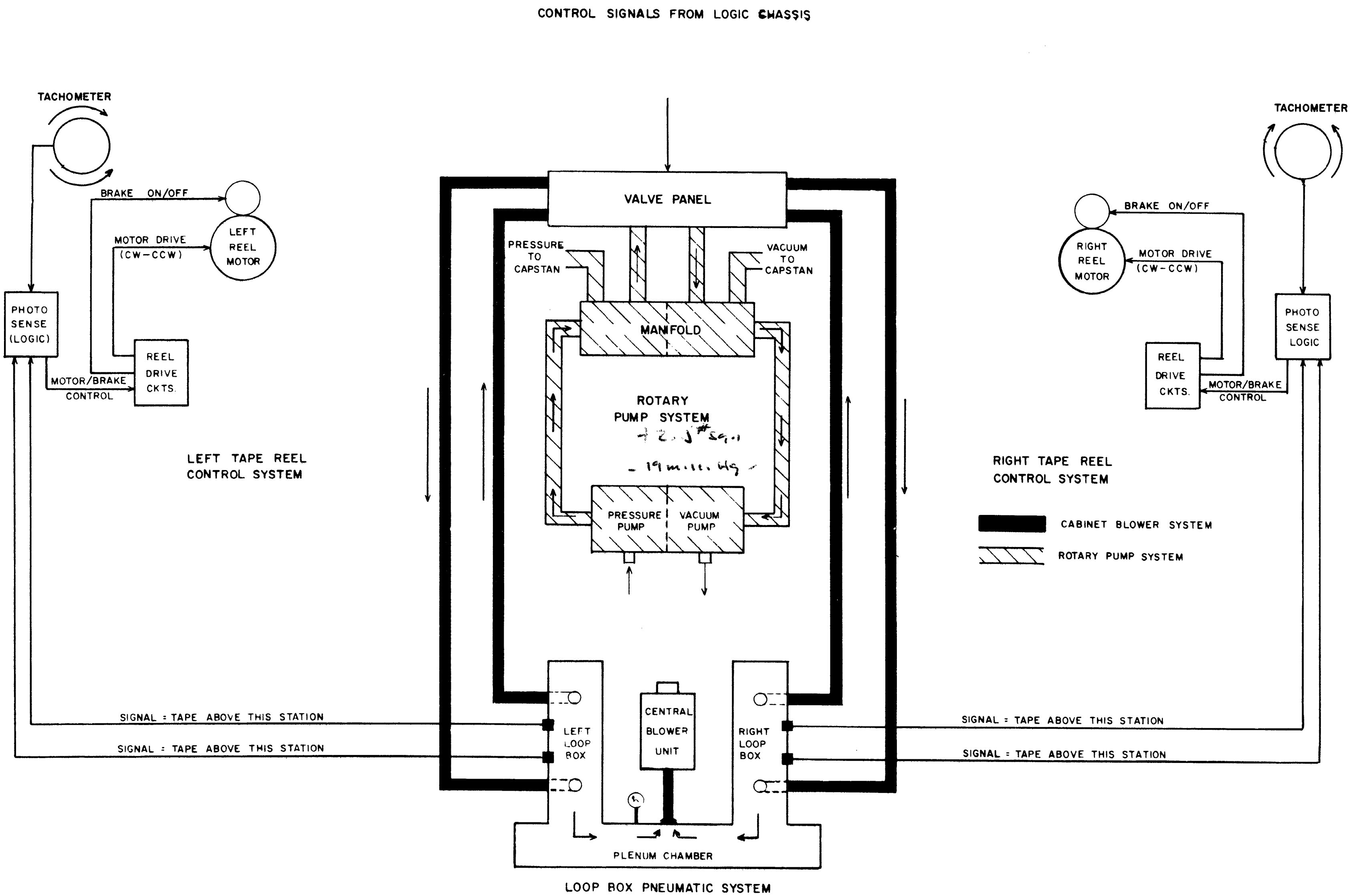


Figure 2-2-6. Pneumatic and Electrical Circuits

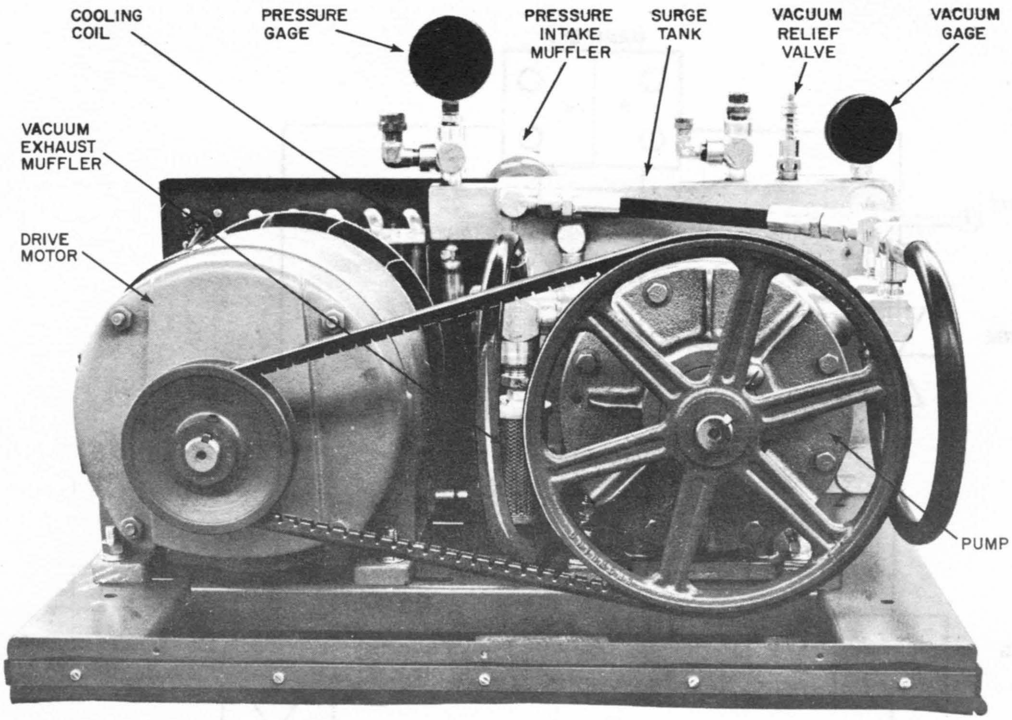


Figure 2-2-7. Rotary Pump System

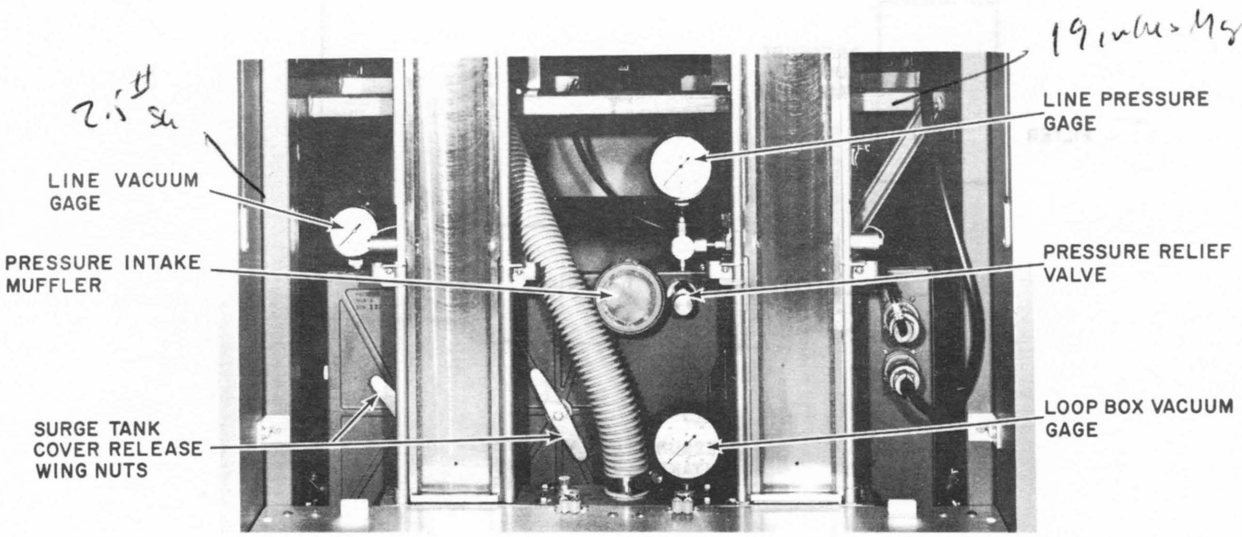


Figure 2-2-8. Rotary Pump System, Front View

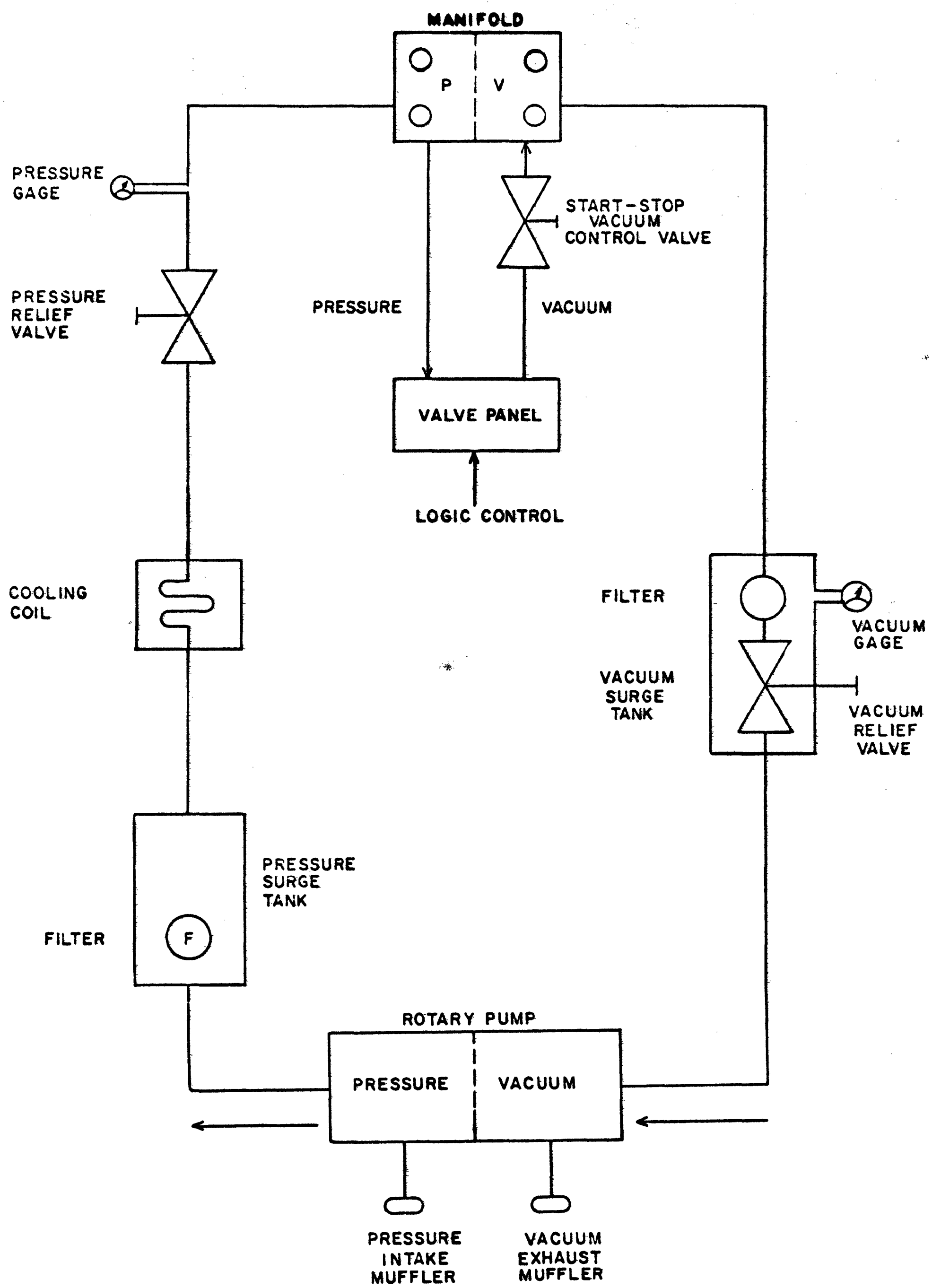


Figure 2-2-9. Vacuum and Pressure Diagram

The dual pump forms independent pressure and vacuum circuits (Figure 2-2-9). The pressure pump draws atmospheric air through an intake muffler which limits operating sound and filters all dust and foreign particles from the air. Compressed air enters the pressure circuit where it is filtered a second time by a filter in the surge tank. The surge tank serves as a reservoir, cancelling pulsation that might appear in the circuit. After filtering, air pressure is passed on to the cooling unit. The cooling coil absorbs heat from the air, which has been generated as a result of high compression, and dissipates the heat to the atmosphere. After being cooled, air pressure enters a relief valve.

The operating pressure can be regulated as required and then passed to the manifold. The pressure supplied to the manifold can be monitored by the 0-5 psi gage.

The vacuum circuit functions in a similar manner. In this case, the vacuum circuit does not employ a cooling coil, and the pump exhaust is passed through a muffler.

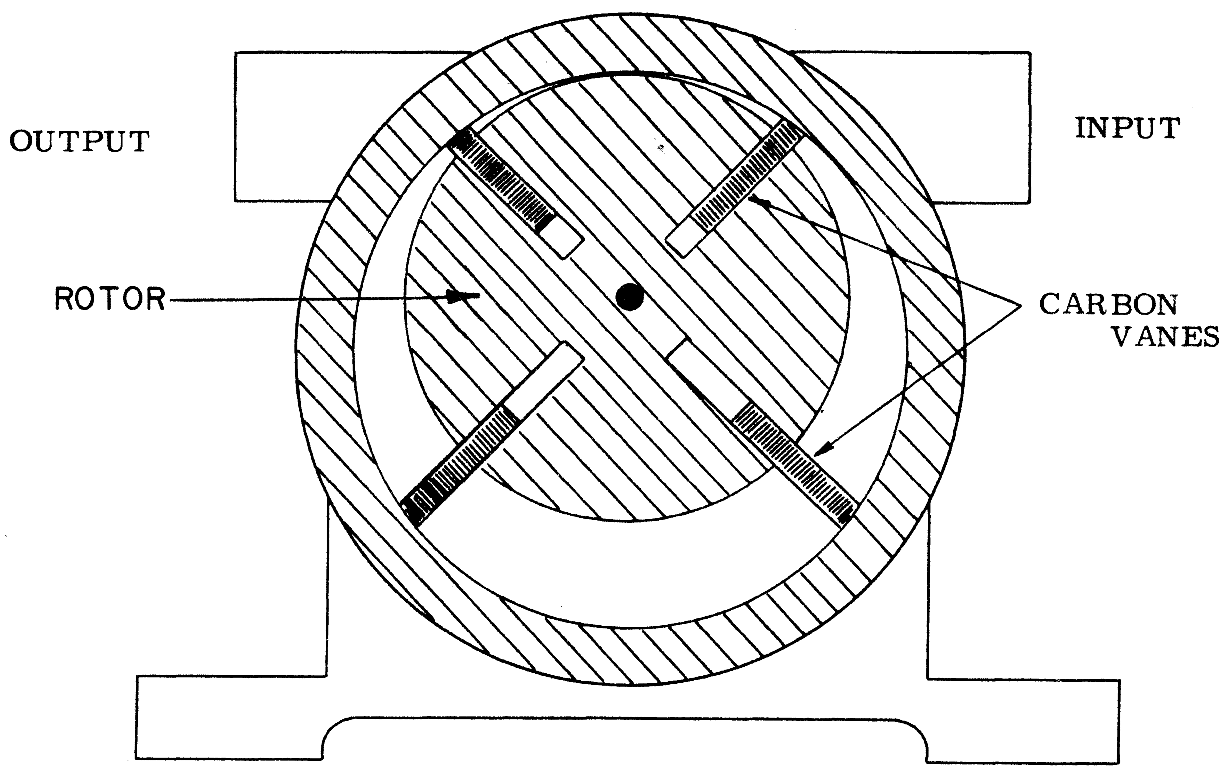


Figure 2-2-10. Carbon Vane Pump

MANIFOLD AND VALVE PANEL

The manifold receives both pressure and vacuum from the rotary pump system and, by means of the manifold ports and valve panel, distributes this pressure and vacuum to all pneumatically controlled components. Refer to Figure 2-2-11. The method of pressure and vacuum distribution for the manifold and valve panel is shown in Figure 2-2-12. Table 2-2-3 describes the function of each valve and port. Figure 2-2-13 gives an exploded view of the valve panel.

The interior construction of the manifold forms a dual chamber which supplies vacuum and pressure to the manifold ports and to both capstan plate assemblies (right and left) through the tape brake assembly (Figure 2-2-14). Each capstan plate assembly (Figure 222-15), located at the lower left or right of the head assembly, is chambered to receive pressure and vacuum directly from the brake. Each assembly contains a capstan valving unit.

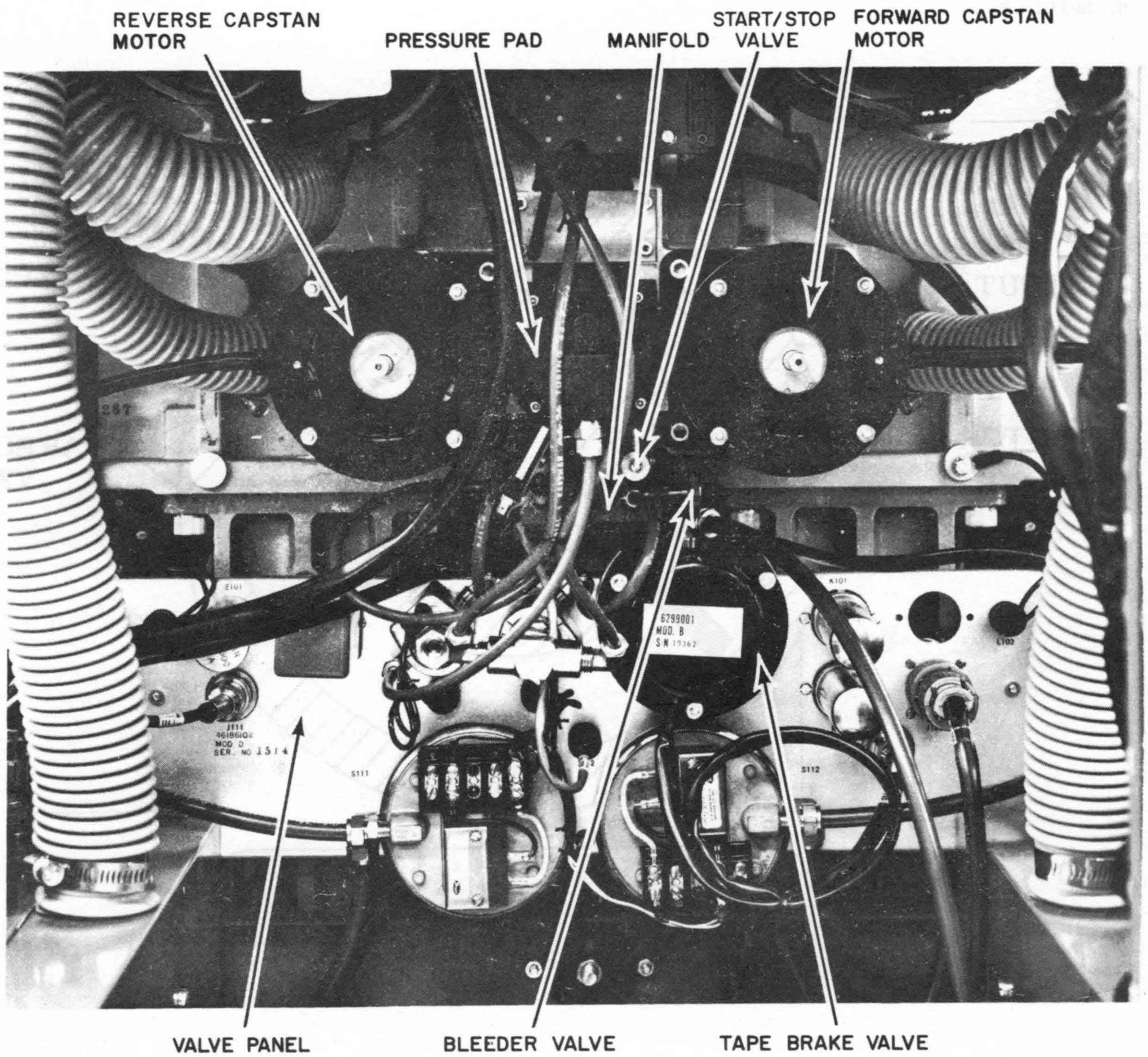


Figure 2-2-11. Manifold and Valve Panel (60-cycle)

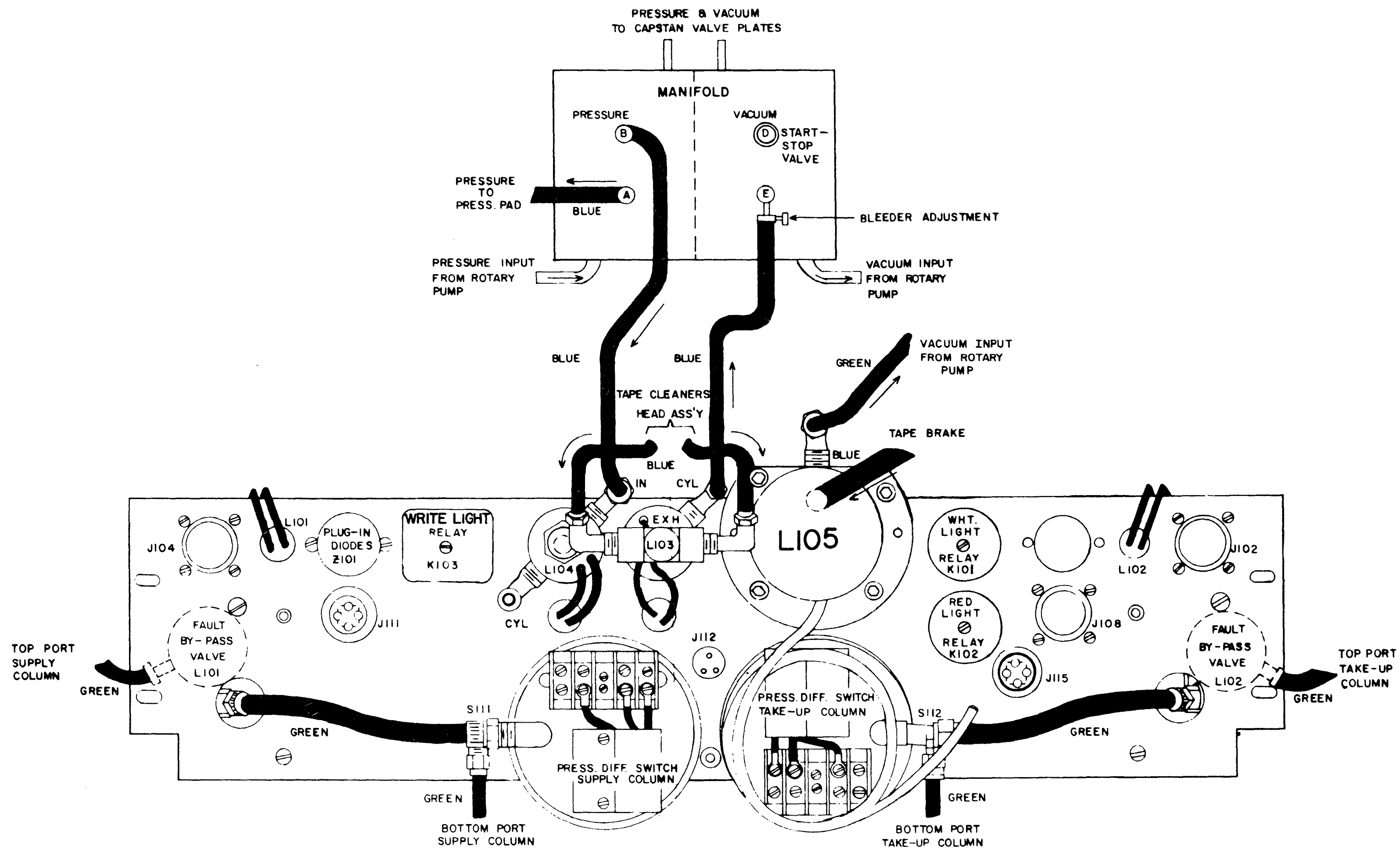


Figure 2-2-12. Vacuum and Pressure Distribution

TABLE 2-2-3. MANIFOLD AND VALVE PANEL

VALVE PANEL	FUNCTION
Pressure Differential Switches (S111 and S112)	These switches sense for a difference in pressure between the upper and lower pneumatic fault ports in the loop box vacuum columns. If no pressure difference exists, it indicates that a tape loop is either above the top port or below the bottom port. In either case, the condition is sensed as a fault except during a load tape operation.
L101 and L102	Initially during a load tape operation, tape covers the top of both vacuum columns creating a vacuum in the columns. Ordinarily, this condition would be sensed as a fault because the loops are positioned above the top ports. In this particular case, however, L101 and L102 bypass the fault condition. This is accomplished by closing both L101 and L102 thereby valving atmosphere to each of the pressure switches. Note that the lower sense port input to both switches is still sensed as vacuum. Thus, a pressure difference is detected which allows the servo system to position tape loops in both vacuum columns. After the loops are formed, L101 and L102 are both closed and the fault bypass is removed.
L103	This valve is connected to vacuum port E on the manifold. The valve allows vacuum to be routed to both the right and left tape cleaners; therefore, tape is always cleaned before passing under the head assembly. The amount of vacuum is controlled by a bleeder adjustment on the manifold.
L104	This valve receives pressure as an input from port B on the manifold. When the valve is open, pressure is routed to the pressure pad piston and the pad assembly is extended. When the valve is closed, pressure is removed and the pressure pad retracts by spring action.
L105	This valve is connected to vacuum port D on the manifold. If the valve is open, vacuum is routed to the brake port and the tape is braked. If the valve is closed, vacuum is removed and tape motion is allowed to continue.

MANIFOLD	FUNCTION
Port A	Routes pressure to the pressure pad assembly. This pressure is used to blow tape against the head assembly during read or write operations.
Port B	Supplies pressure to L104 on the valve panel which extends the head pad.
Port D	Port D is connected to L105 on the valve panel and allows vacuum to be applied to the brake port when the valve is open.
Port E	Supplies vacuum controlled by a bleeder adjustment to L103 (valve panel). This valve routes vacuum to the right and left tape cleaners.

7 - VALVE ASSEMBLY
9 - VALVE BLOCK ASSEMBLY
10 - PLUG-IN DIODE
11 - RELAY
12 - PRESSURE DIFFERENTIAL SWITCH
27 - SOLENOID VALVE
45 - INLET DUST FILTER

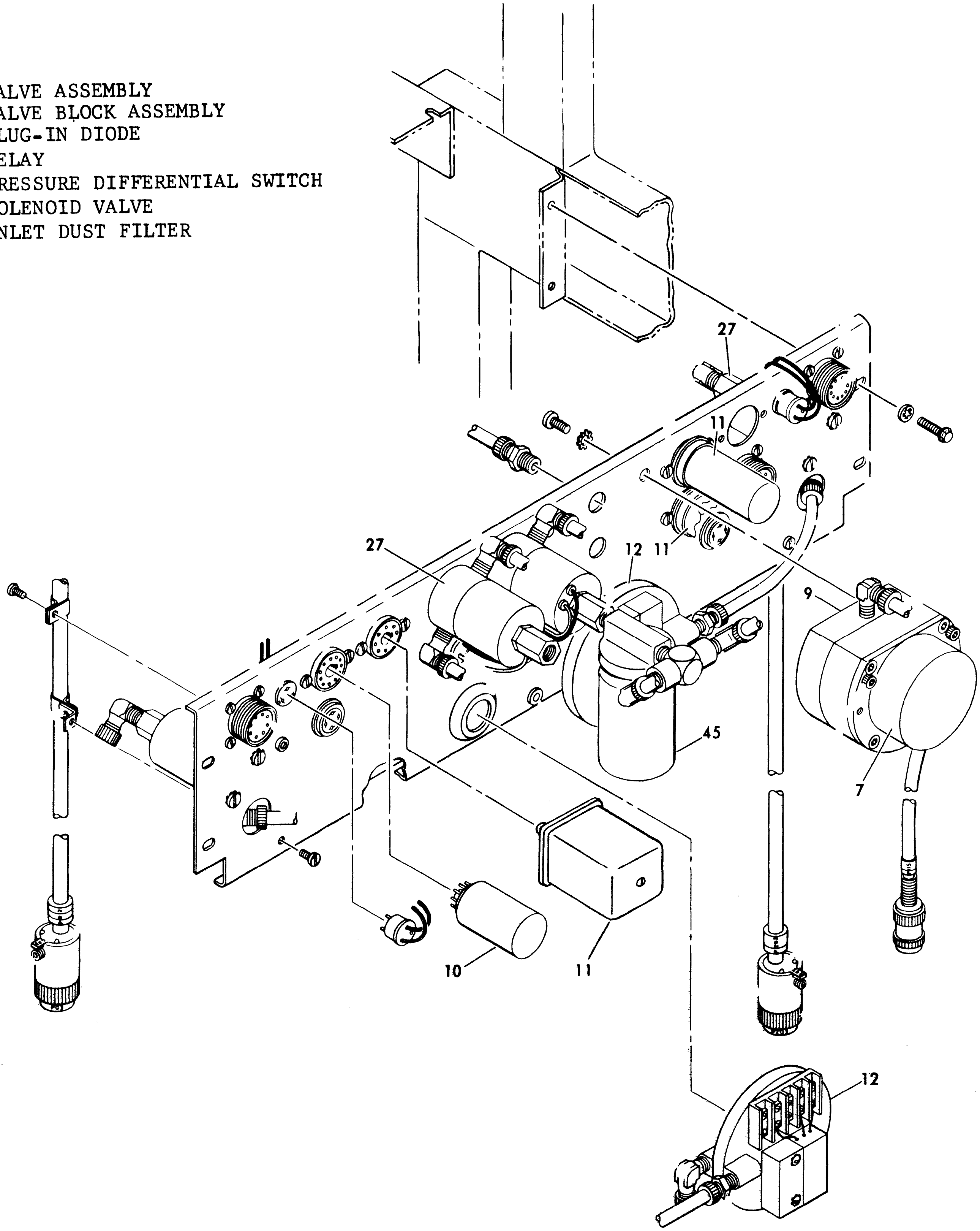


Figure 2-2-13. Valve Panel Assembly

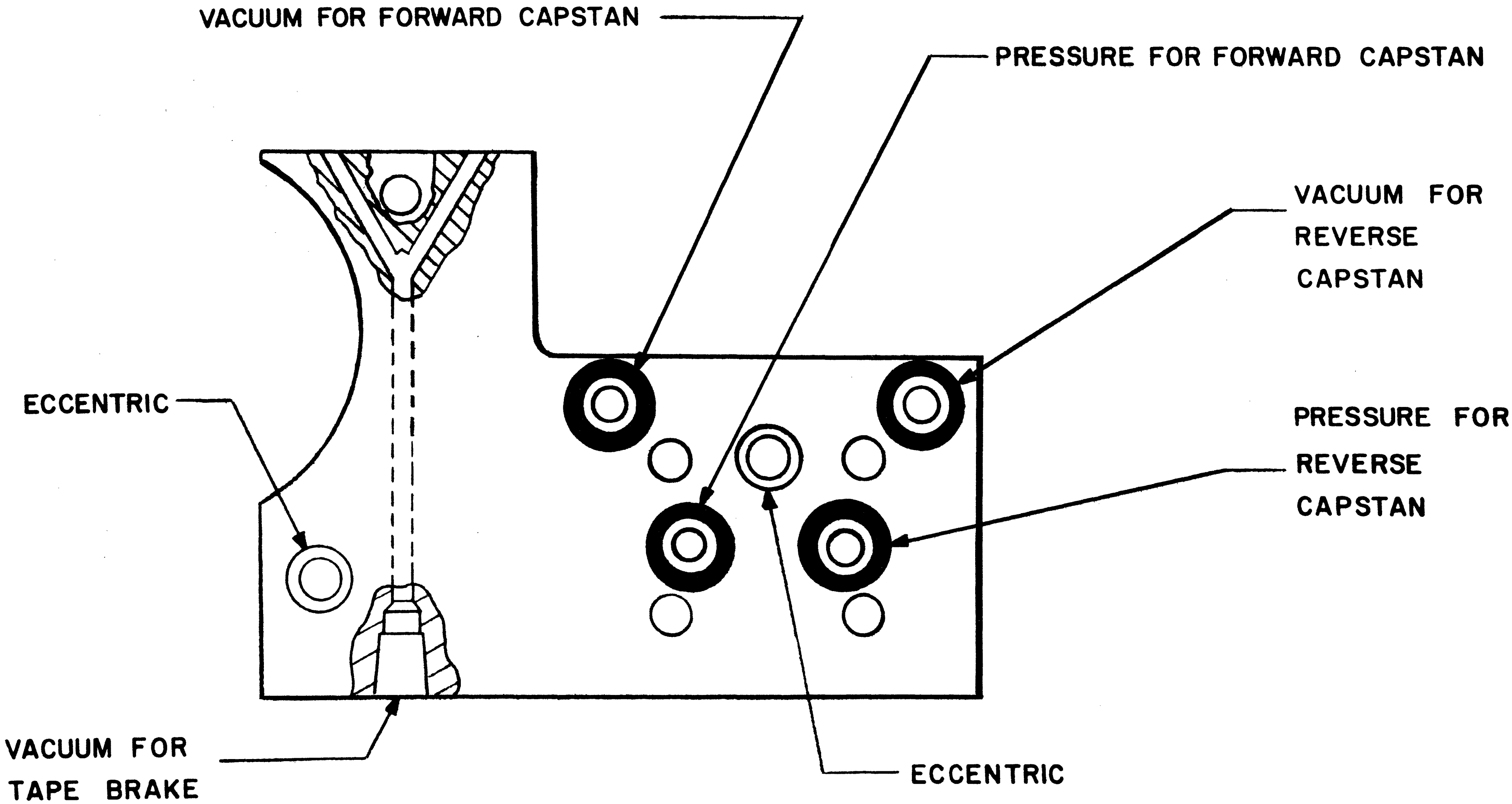


Figure 2-2-14. Brake Block

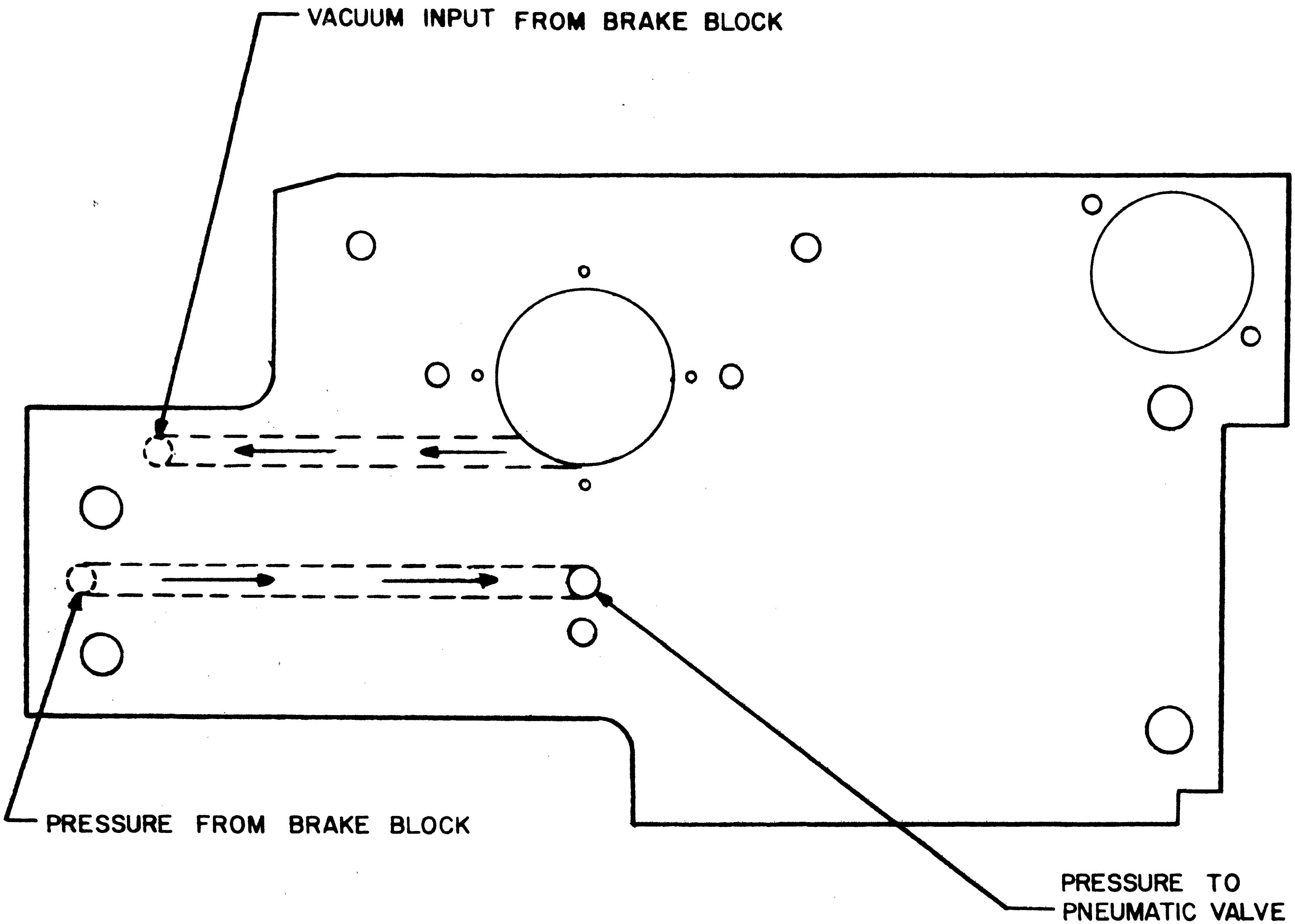
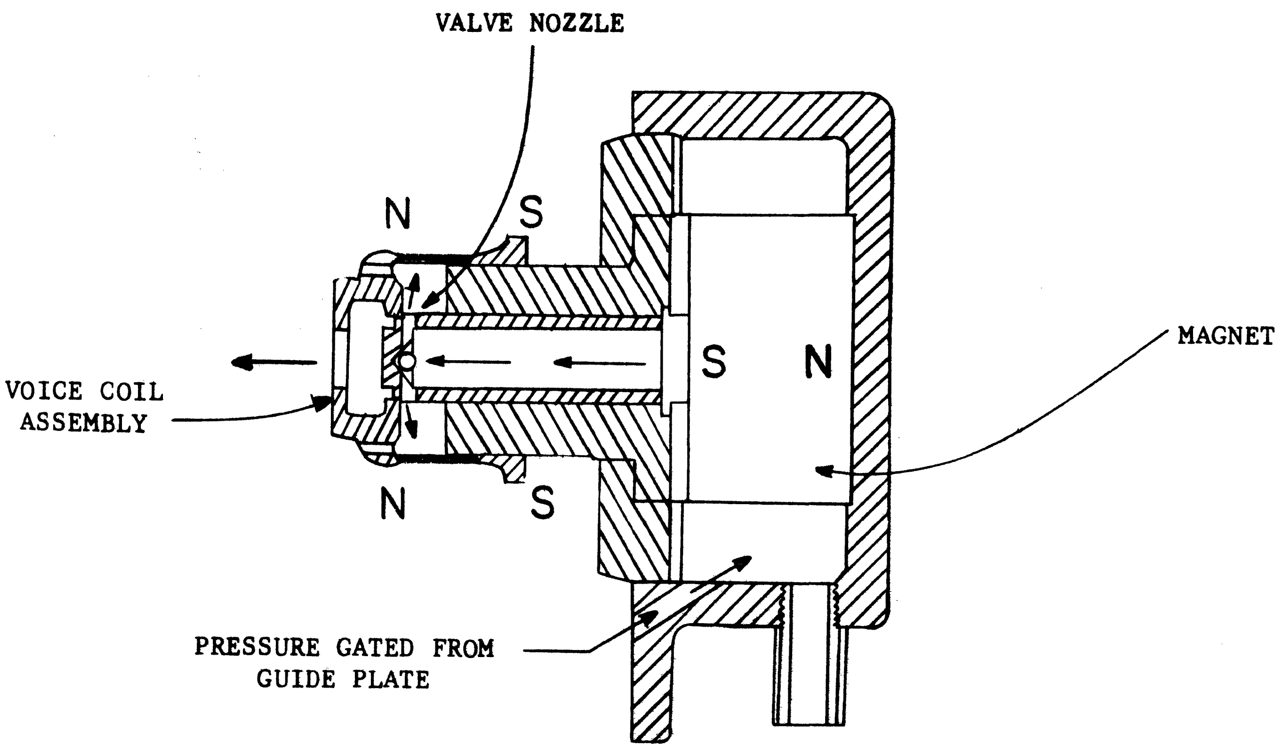


Figure 2-2-15. Right Guide Plate

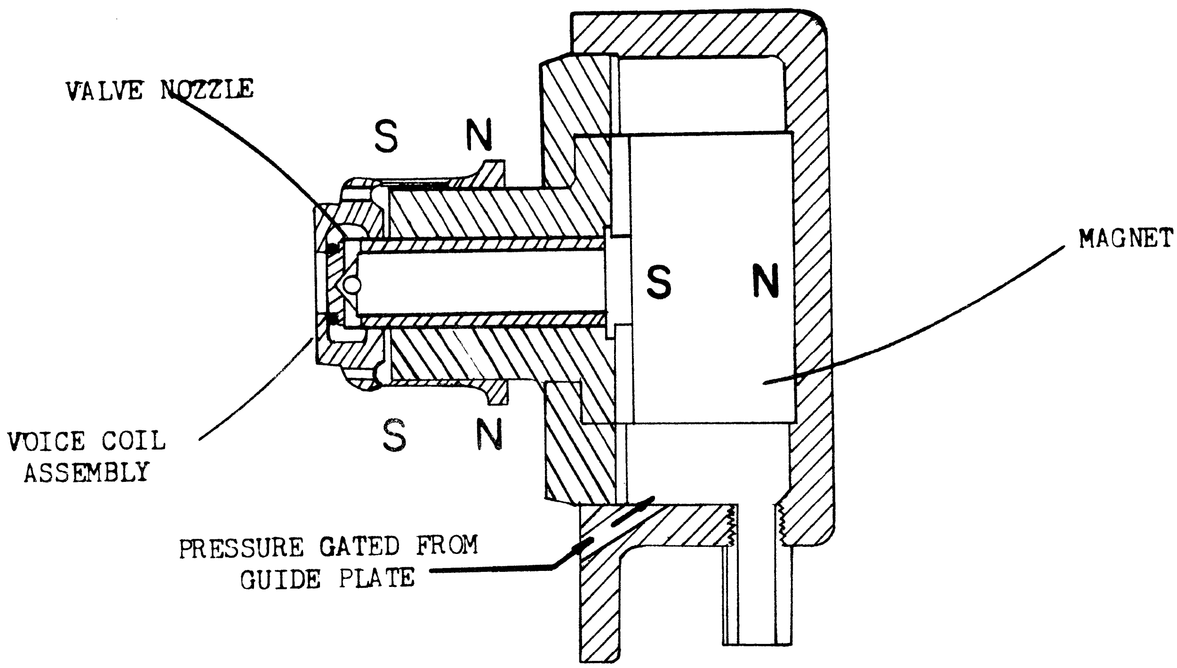
The capstan valves (Figures 2-2-16 and 2-2-17) contain voice-coil actuated pneumatic valve assemblies which receive control signals from the capstan drive and brake control logic circuits. When the capstan wheels are rotated in opposite directions by the individual capstan motors, signals to the capstan valves from the logic circuits dictate whether vacuum or pressure is valved to the capstan. A capstan is supplied with vacuum in a drive condition and with pressure in a nondrive state.



The direction of current flow through the voice coil creates like poles with respect to the permanent magnet; therefore, the voice coil is repelled and extends outward. Pressure will be gated to the capstan since the voice coil assembly no longer covers the valve nozzle.

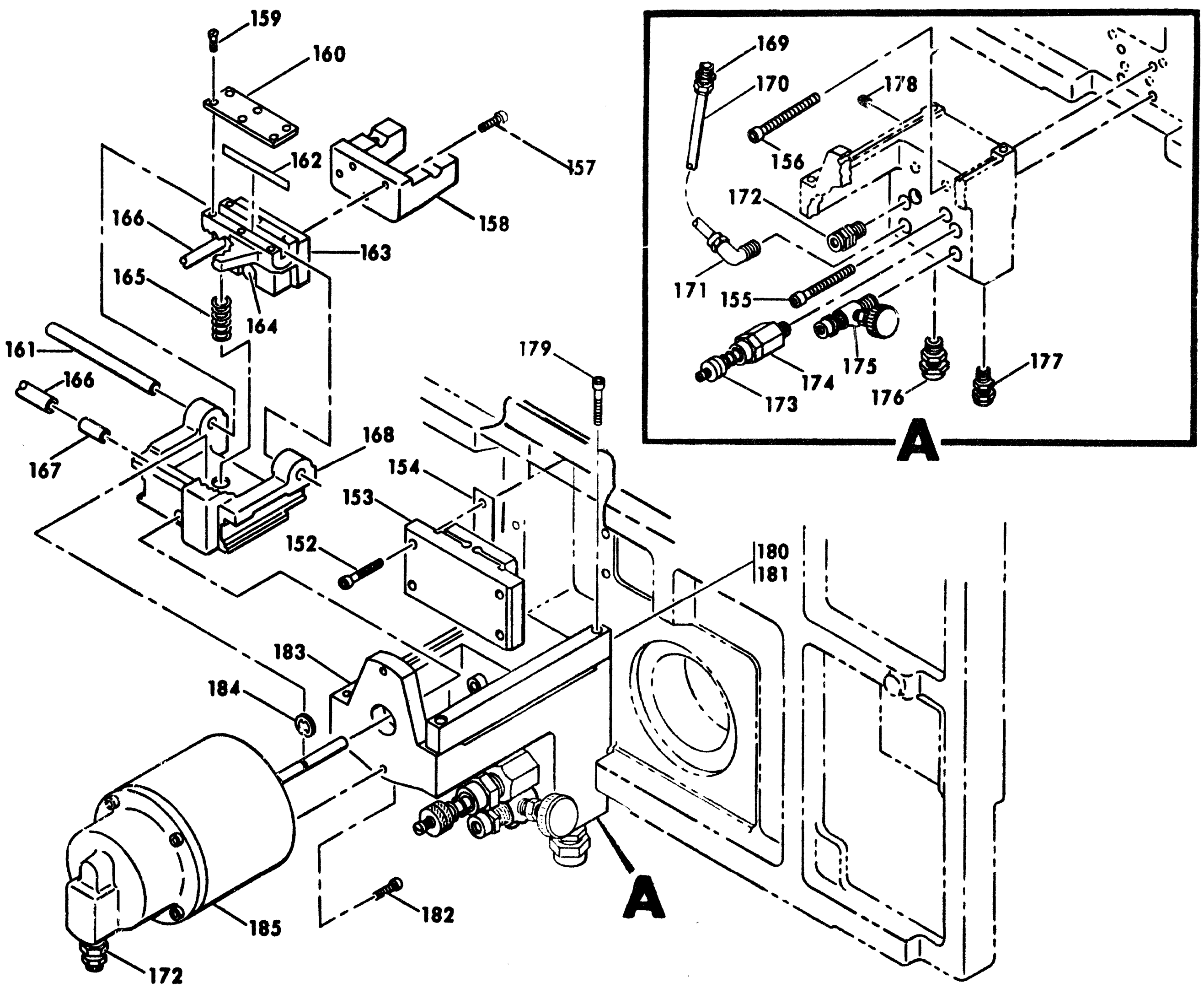
Figure 2-2-16. Capstan Valve Assembly

Pressure and vacuum are directly supplied to the manifold ports from the interior chambers of the manifold. Port A (Figure 2-2-12) supplies constant pressure to the pad slots. The slotted pad moves into position under the magnetic tape when the pressure pad is extended. Manifold port B is connected to L104 which controls the extension and retraction of the pressure pad. When solenoid is energized by the pad extend logic circuit, pressure is applied to the pressure pad piston and the pad is extended. When the solenoid is de-energized, pressure is removed and the pad is retracted. Figure 2-2-18 shows the pressure pad assembly with all the associated components. Figure 2-2-19 is an exploded view of the cylinder assembly. Figure 2-2-20 illustrates the internal configuration of the cylinder assembly.



The direction of current flow through the voice creates unlike poles with respect to the permanent magnet; therefore, the voice coil is attracted back towards the south pole of the permanent magnet. Pressure will not be gated to the capstan since the voice coil assembly covers the valve nozzle.

Figure 2-2-17. Capstan Valve Assembly

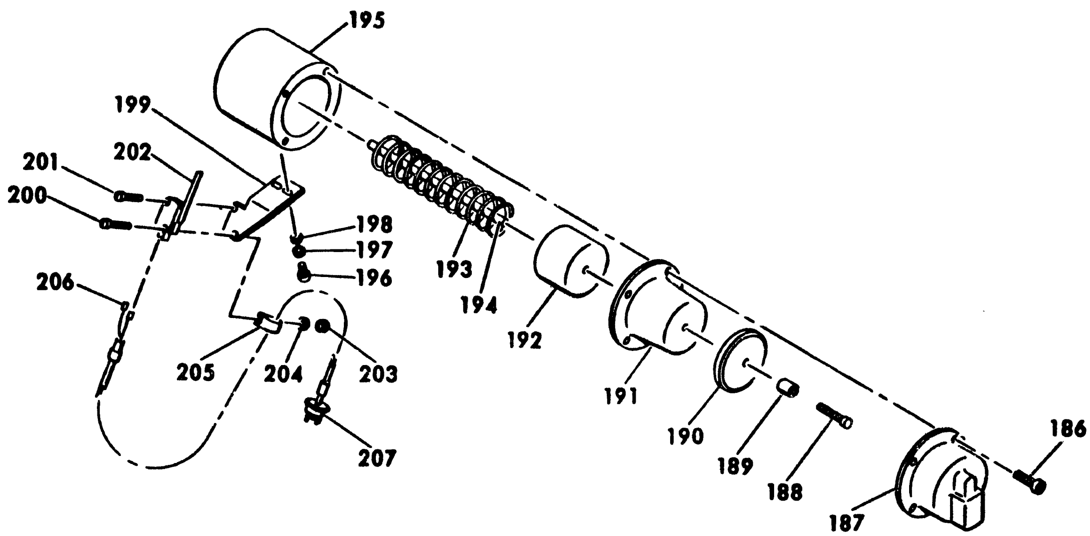


152 - Cap screw
153 - Head assembly base
154 - Base shim
155 - Cap screw
156 - Cap screw
157 - Machine screw
158 - Fork lever
159 - Machine screw
160 - Hold down plate
161 - Rocker arm shaft
162 - Rocker arm shaft shim

163 - Rocker arm
164 - Rocker arm pad
165 - Rocker arm spring
166 - Rubber tubing
167 - Hose fitting
168 - Slide
169 - Fitting
170 - Plastic tubing
171 - Elbow fitting
172 - Fitting
173 - Vacuum relief valve

174 - Pipe connector
175 - Needle valve
176 - Fitting
178 - Pin plug
179 - Cap screw
180 - Track
181 - Track shim
182 - Cap screw
183 - Manifold
184 - Retaining ring
185 - Cylinder assembly

Figure 2-2-18. Tape Deck Assembly



186 - Cap screw

187 - Head cylinder

188 - Hex head machine screw

189 - Piston stop

190 - Diaphragm retainer plate

192 - Diaphragm piston

193 - Piston spring

194 - Push-rod rocker arm

195 - Pressure cylinder

196 - Machine screw

197 - Lock Washer

198 - Flat washer

199 - Switch bracket

200 - Machine screw

201 - Machine screw

202 - Switch

203 - Hex nut

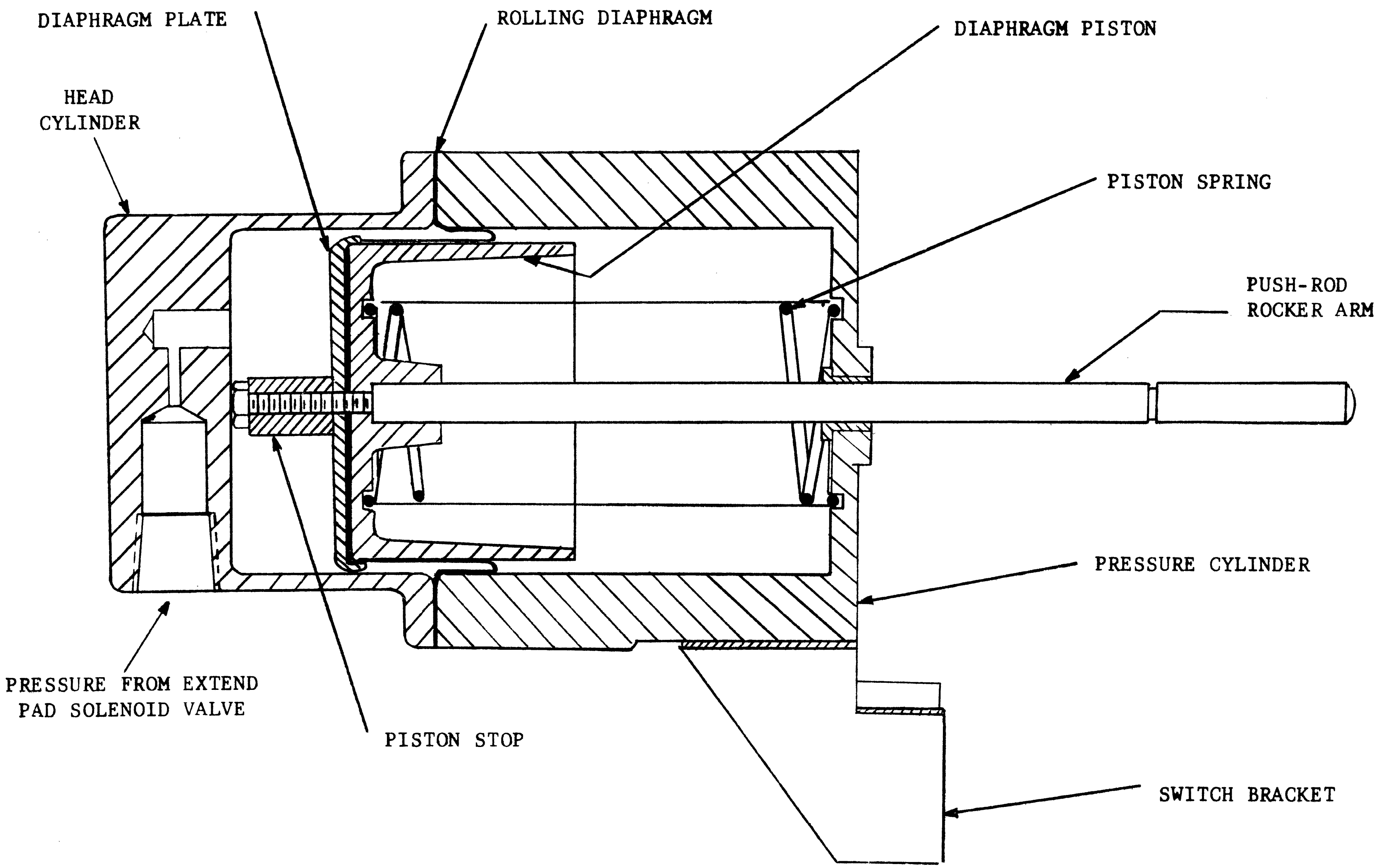
204 - Flat washer

205 - Cable clamp

206 - Slide on receptacle

207 - Miniature plug

Figure 2-2-19. Cylinder Assembly - Exploded View


DIAPHRAGM PLATE
ROLLING DIAPHRAGM
DIAPHRAGM PISTON
HEAD CYLINDER
PISTON SPRING
PUSH-ROD ROCKER ARM
PRESSURE CYLINDER
PRESSURE FROM EXTEND PAD SOLENOID VALVE
PISTON STOP
SWITCH BRACKET

When pressure is removed, the piston spring will return the rocker arm back to its original position (back to the piston stop). This is when the pad is retracted.

The solenoid valves (L101-L104) work on the principle illustrated in Figure 2-2-21. In the de-energized position, there is a path from the EXH port to the CYL port. In the energized position, the path from EXH to CYL is blocked and a path from CYL to IN is opened. Therefore, according to the vacuum or pressure connections, the valve can control various operations by acting as a pneumatic control switch.

Manifold valve D is connected to the vacuum on the surge tank. Valve L105 is similar to the capstan valves and is controlled by the same logic control section. Two input vacuum lines are connected to L105; one from the tape brake port and the other from the loop box plenum chamber.

Vacuum port E is fitted with a bleeder adjustment valve and flexible tubes connected to the magnetic tape cleaners via solenoid valve L103. As tape passes under the head assembly, tape cleaners at each side of the head hold the tape in close contact and remove dust and foreign particles. The solenoid coil in L104 is energized and de-energized by the pad extend logic circuit.

The left and right pressure differential switches (S111 and S112) connect between the upper and lower pneumatic ports of the take-up and supply loop box columns. Each switch contains a pressure sensitive diaphragm which performs an electrical switching function when a tape loop is positioned above the top pneumatic port or below the bottom port. If a pressure differential does not exist between the tape ports, the switch remains open to signify that a fault condition exists. NOTE: A "no tape loop condition" can also cause this indication.

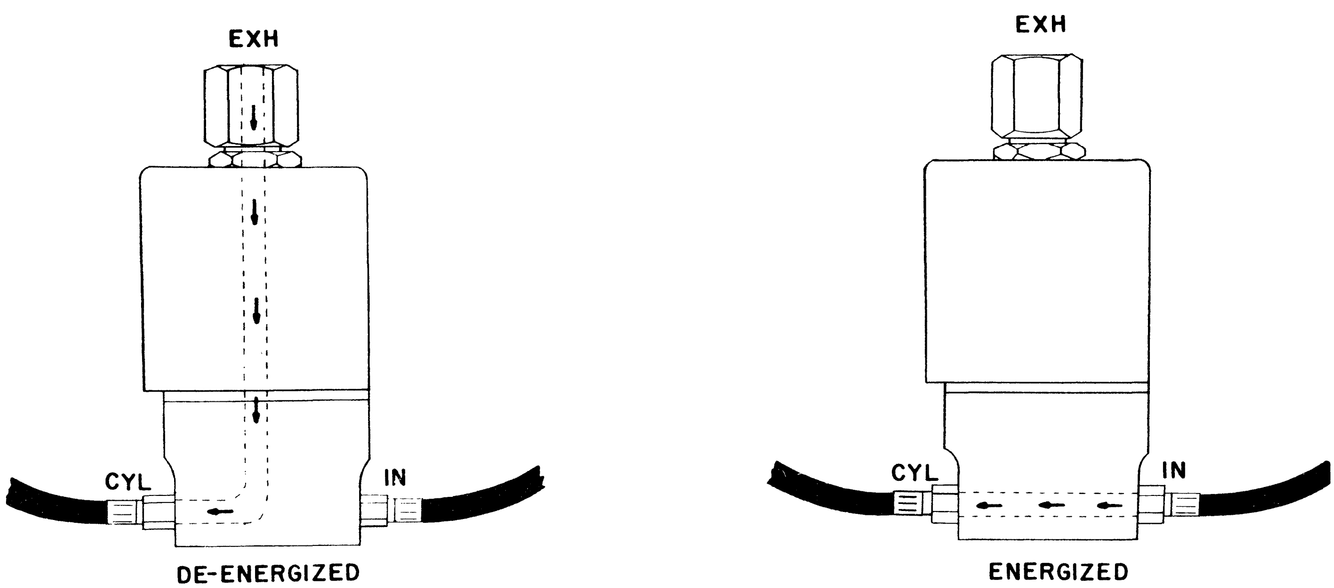
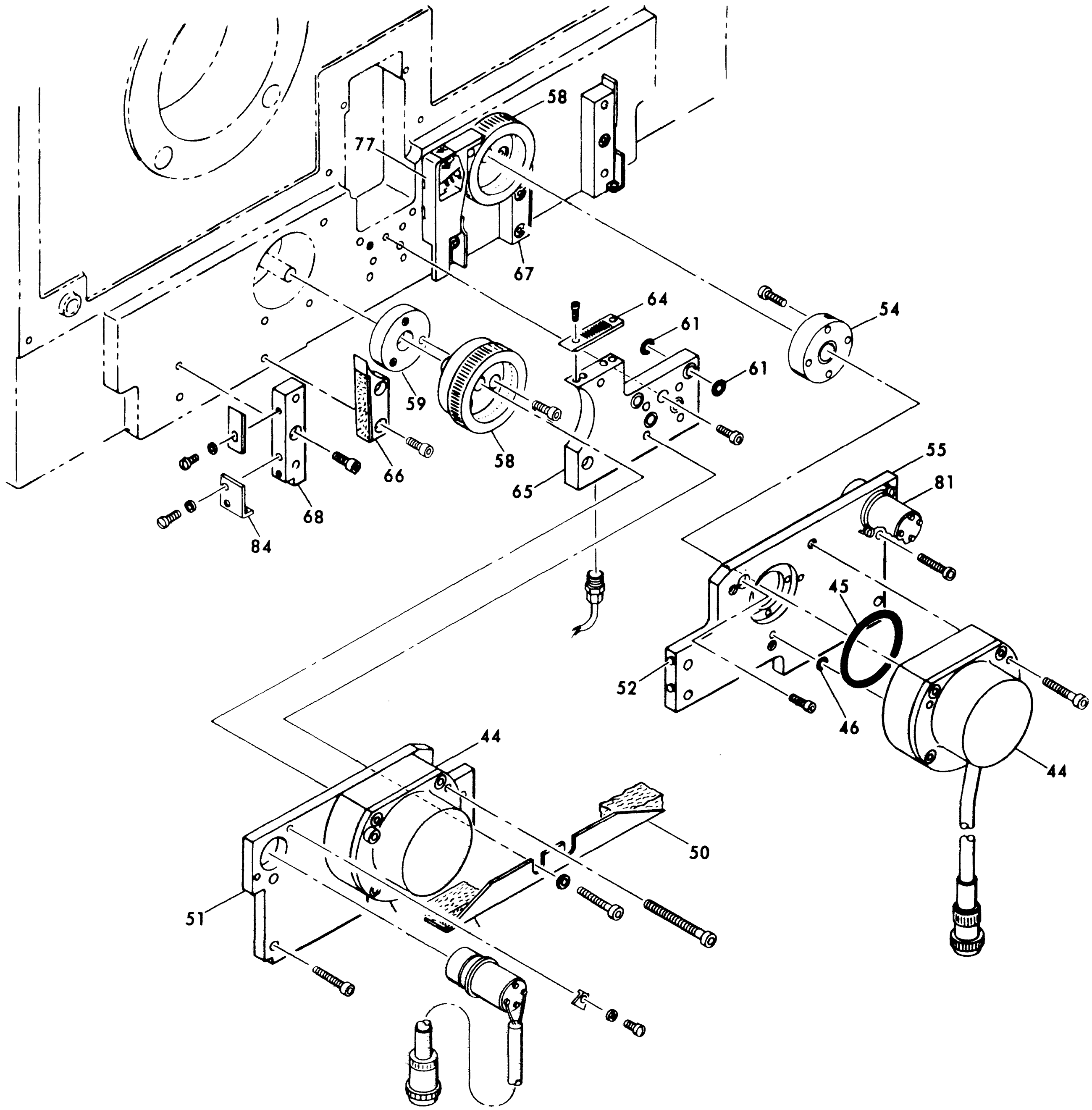


Figure 2-2-21. Solenoid Valve

The alternate condition exists when the tape loop is positioned between the pneumatic sensing ports. Because of tape width and its limited clearance within the loop box, a decided difference in pressure now exists between sensing ports. The diaphragm within the differential switch is actuated and the electrical circuit is closed to signify a "normal condition" within the loop box column.

Solenoid valves L101 and L102 perform a fault bypass function which assists the tape load operation. When tape is initially loaded, no pressure difference (but full vacuum) exists between pneumatic ports in the loop box columns. This fault condition, which normally would stop operation, is by-passed when the Load switch is pressed as L101 and L102 are energized. The valves close and a pressure difference is sensed by the differential switches. The servo system can then position tape loops in both columns. After the loops are formed, L101 and L102 are de-energized and the fault by-pass is removed.

Figure 2-2-22 illustrates the tape deck assembly with location of components. This should be used during the mechanical assembly/disassembly phase for proper identification and location of parts.



TAPE DECK ASSEMBLY

59 - CAPSTAN CLAMP RING
61 - O-RING
64 - BRAKE PAD
65 - BRAKE BLOCK
66 - LEFT STRIPPER
67 - RIGHT STRIPPER
68 - LEFT SPACER
77 - L.P. AND E.O.T. ASSEMBLY
81 - TACHOMETER
84 - LEFT HAND HINGE

44 - CAPSTAN VALVE
45 - O-RING
46 - O-RING
50 - SOUND BAFFEL
51 - LEFT COMMUTATOR AND PLATE ASSEMBLY
52 - PLUG
54 - COMMUTATOR
55 - RIGHT GUIDE PLATE
58 - CAPSTAN

Figure 2-2-22. Tape Deck Assembly Parts List

CHAPTER III

MECHANICAL DISASSEMBLY AND ASSEMBLY PROCEDURE

CHAPTER III

MECHANICAL DISASSEMBLY AND ASSEMBLY PROCEDURE

CAPSTAN VOICE COIL

1. Disconnect the capstan connector, P305, from the top of the reel drive chassis.
2. Remove the three screws and capstan valve as shown in Figure 2-3-1.
3. Procure a replacement valve and remove the O-ring from the groove in the housing.
4. Using the height gage, part number 84012300, perform the check for proper distance from top of the voice coil to valve housing. Refer to Figure 2-3-2.
5. Adjust the nozzle for correct height with the aid of an adjusting wrench, part number 84001700. Refer to Figure 2-3-2. Install the O-ring into the large groove in the valve housing.

NOTE: If operation is unsatisfactory after this adjustment, adjust the distance between the top of the voice coil to the valve housing. Use a height gage to obtain optimum performance.

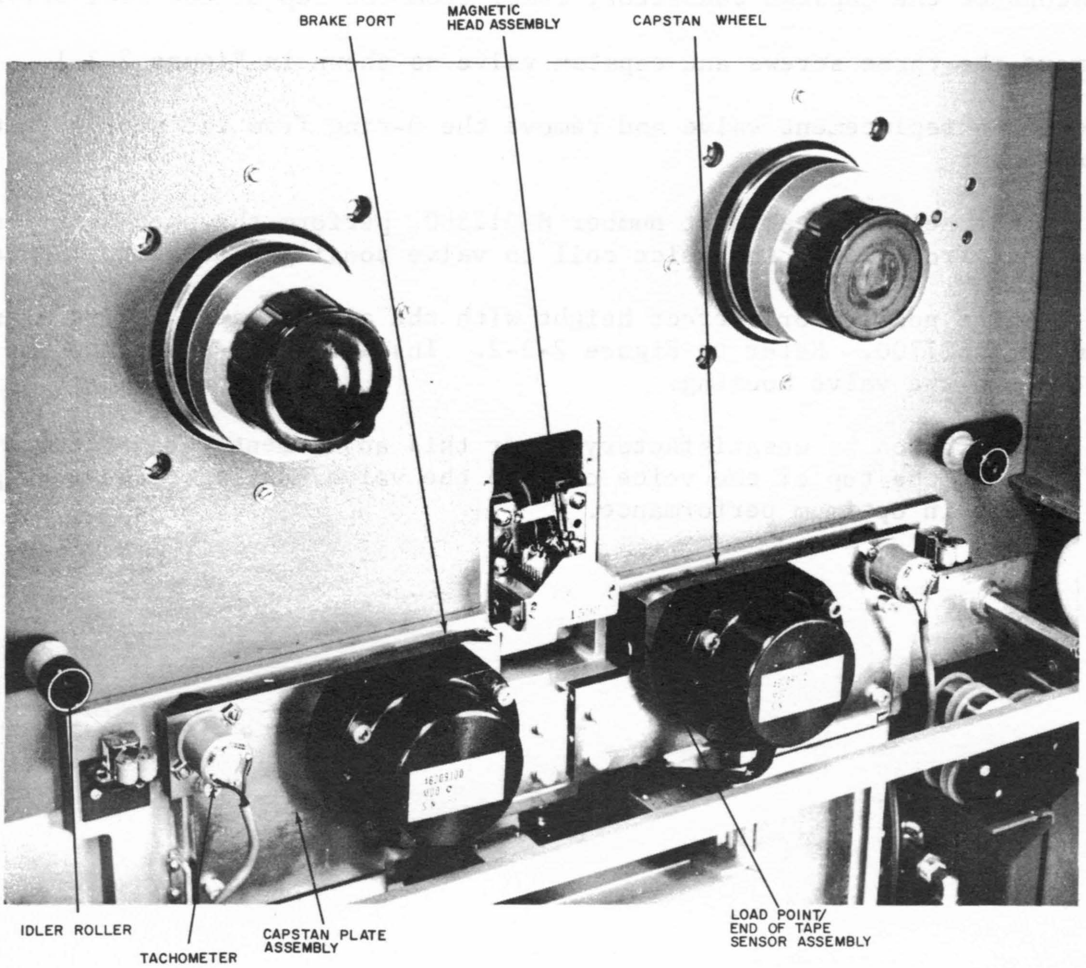


Figure 2-3-1. Tape Deck

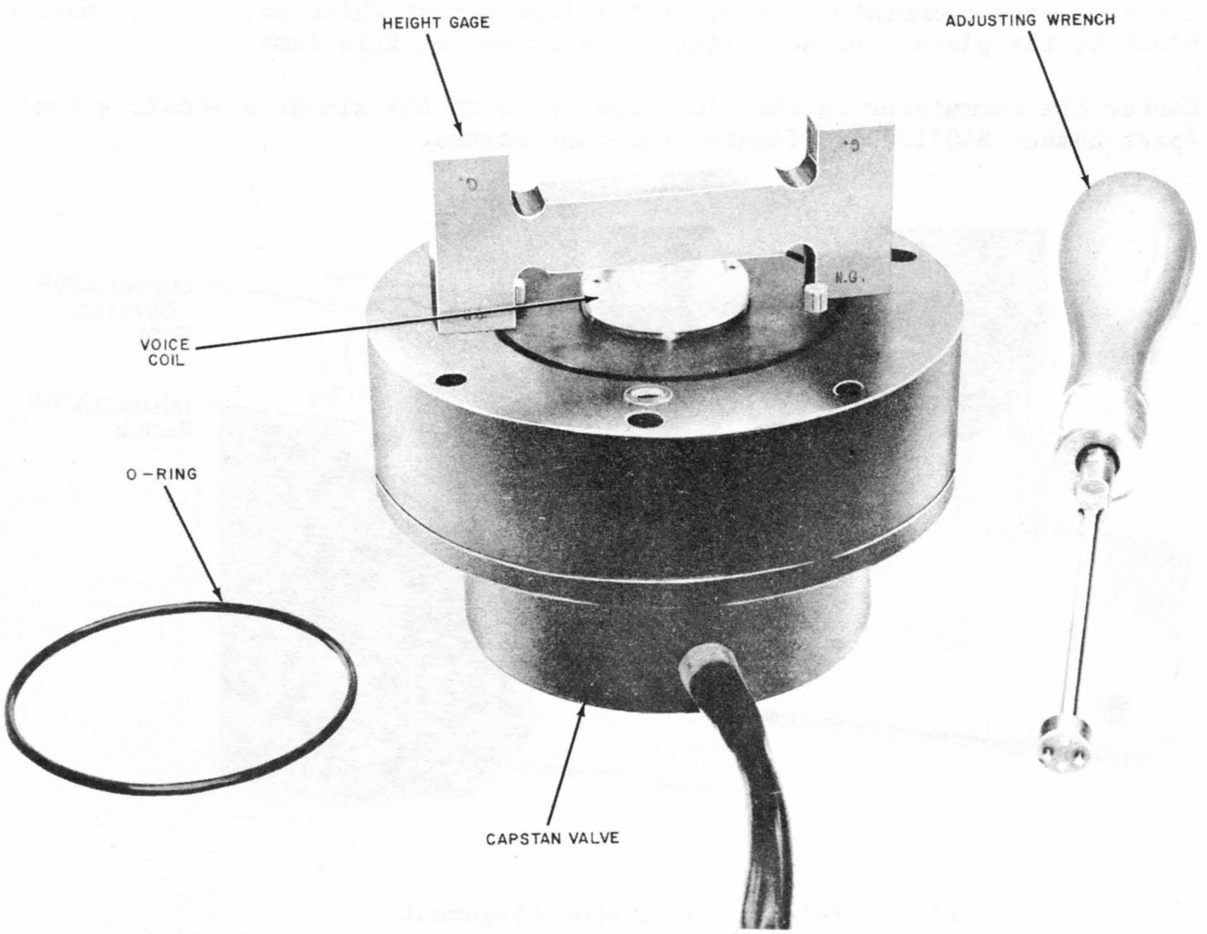


Figure 2-3-2. Voice Coil Height Adjustment

TACHOMETER REMOVAL

1. Disconnect P101 and P105 (front panel must be removed).
2. Remove two holding screws from each tachometer (exercise care in handling tachometers, as diodes may be damaged.)

CAPSTAN PLATE ASSEMBLY REMOVAL

1. Remove the screws holding the plate to the front of the unit.
2. Lift the plate from the unit and remove the four commutator block screws. Refer to Figure 2-3-3.

3. Install a new commutator. Replace the four screws which hold the commutator block to the plate. Do not tighten the screws at this time.

4. Center the commutator in the plate opening with the aid of a locating tool (part number 84011300). Tighten the four screws.

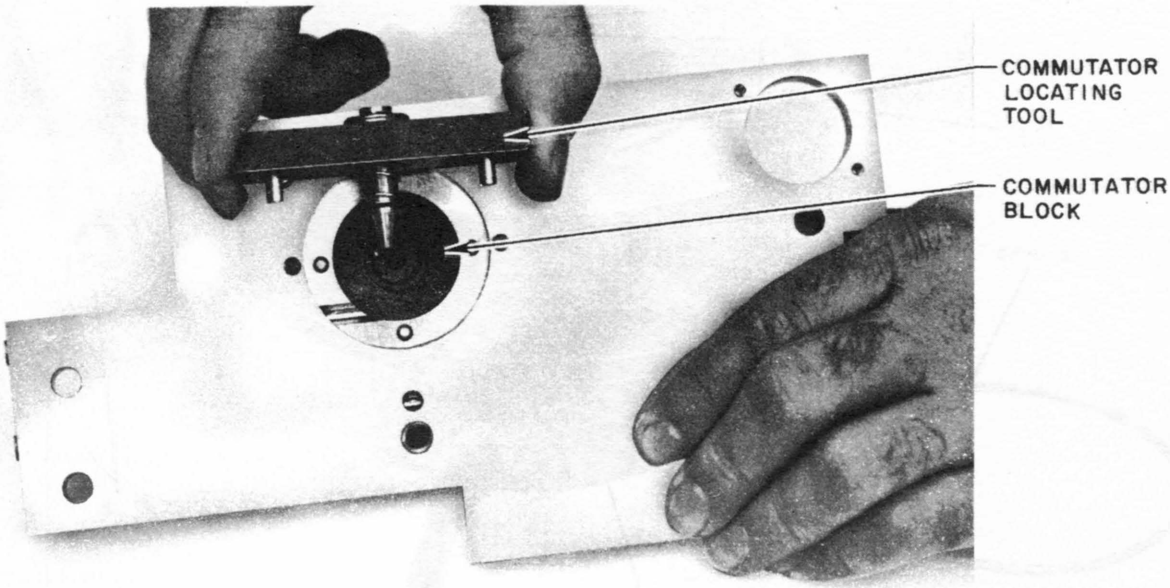


Figure 2-3-3. Commutator Alignment

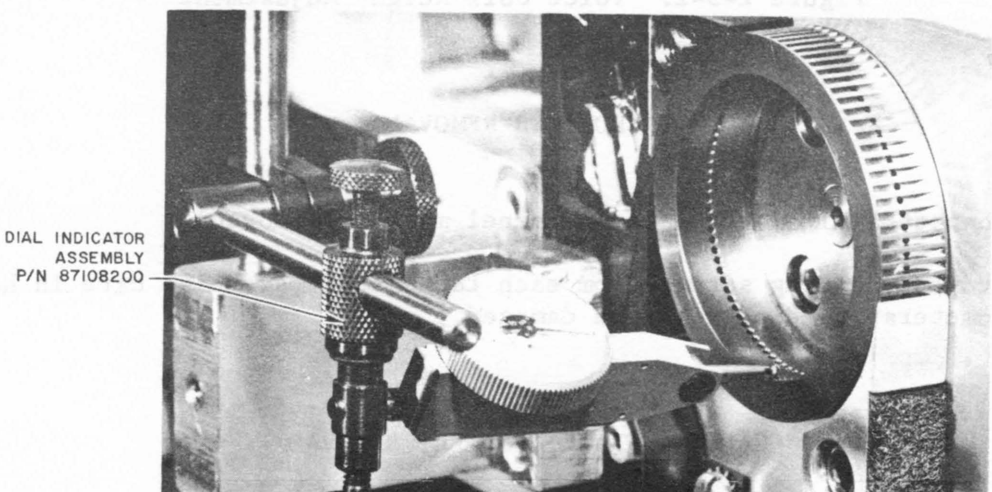


Figure 2-3-4. Capstan Wheel Adjustment

LOAD POINT/END OF TAPE SENSOR ASSEMBLY REMOVAL

1. Disconnect P103 from the connector panel.
2. The assembly can be removed from the tape deck by pushing up on the sensor assembly tongue which protrudes below the valve guide plates. This releases the assembly and it can be pulled up and away from the tape transport.

TAPE STRIPPER REMOVAL

1. Remove two holding screws.
2. Remove tape strippers.

CAPSTAN WHEEL REMOVAL

Loosen the three capstan screws shown in Figure 2-3-4. With a hammer and a short length of 3/8-inch diameter rod, tap one of the screws to free the ring clamp from the capstan wheel. Remove the capstan.

CAPSTAN WHEEL REPLACEMENT

1. Install capstan wheel. Shim for a clearance of 0.004 to 0.006 inch between the wheel and tape deck.
2. Secure the replacement wheel with the three screws. Tighten the screws to finger tightness.
3. Attach the dial indicator (Figure 2-3-4). The tool (part number 87108200) consists of a dial indicator, spindle clamp, base and bracket.
4. Place the indicator needle on the inside surface of the wheel and rotate the capstan motor from the rear of the unit.
5. Adjust the capstan by means of the three screws until the dial indicates less than a 0.0003 inch deviation as the wheel is rotated through one revolution.
6. If the dial reading is positive, tighten the capstan screw on the side opposite the gage needle. If the dial reading is negative, rotate the capstan 180° and tighten the screw on the side opposite the gage needle.

7. When the capstan screws are tightened, the dial reading should not vary more than 0.0003 inch for one revolution. If the deviation is greater than specified, repeat steps 2 through 7. A new capstan must be installed if the old capstan cannot be adjusted to meet these requirements.

TAPE STRIPPER INSTALLATION AND ADJUSTMENT

1. Install tape stripper, do not tighten screws.

2. Adjust the strippers for a clearance of 0.001 to 0.002 inch between the capstan and the stripper point (Figure 2-3-5). The felt side of the strippers should align flush with the felt side of the loop boxes.

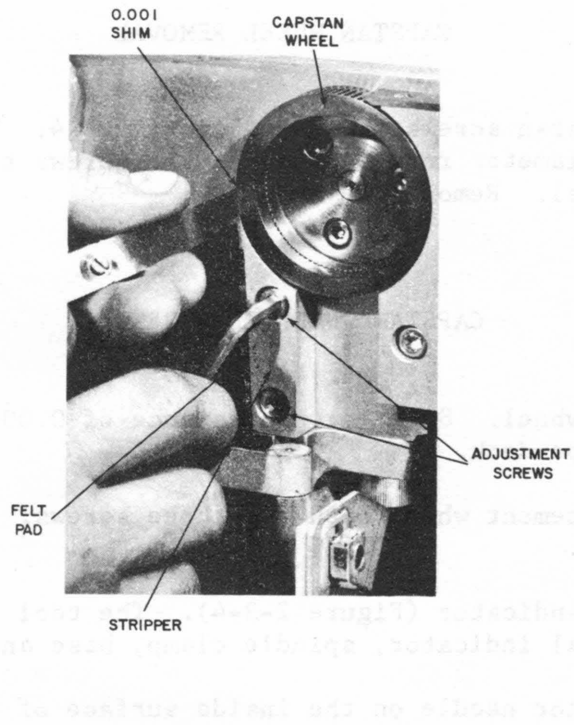


Figure 2-3-5. Stripper Adjustment

MAGNETIC HEAD ASSEMBLY REMOVAL

1. Remove the two screws and head cover.

2. Remove the holding screws from the cable connectors located at the rear (behind tape deck) and disconnect head connectors P106 and P107 (Figure 2-3-6).

3. Disconnect the two vacuum lines (at the rear of unit) from the tape cleaners.

4. Remove the four head-mounting screws (Figure 2-3-7). Support the head assembly while removing the screws.

CAUTION

Do not allow the head surface or cleaner to touch any surface.

5. Carefully lift head assembly from the mounting position, passing cables and connectors through opening in tape deck.

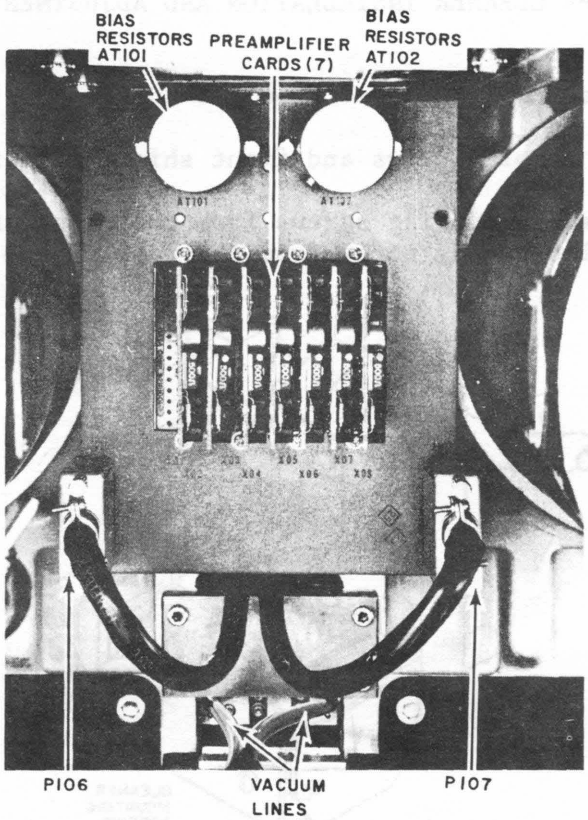


Figure 2-3-6. Head Termination Assembly

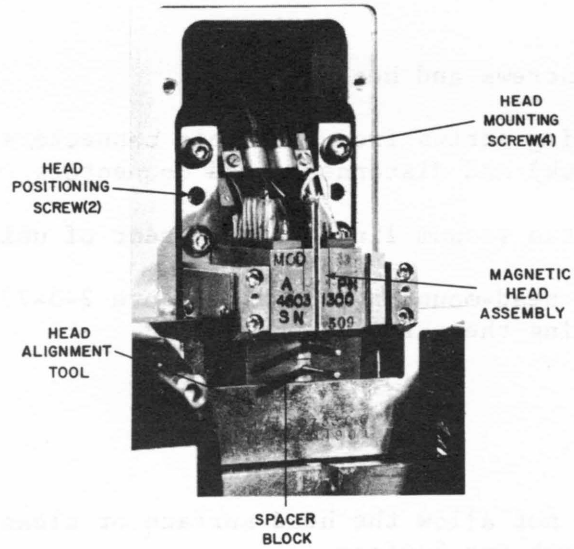


Figure 2-3-7. Magnetic Head Alignment

TAPE CLEANER INSTALLATION AND ADJUSTMENT

With the entire head assembly removed from the unit:

1. Remove the two shield screws and front shield (figure 2-3-8)

2. Remove the cleaner mounting screws from the front of the Lead. Do not remove or loosen any screw from the rear of the plate.

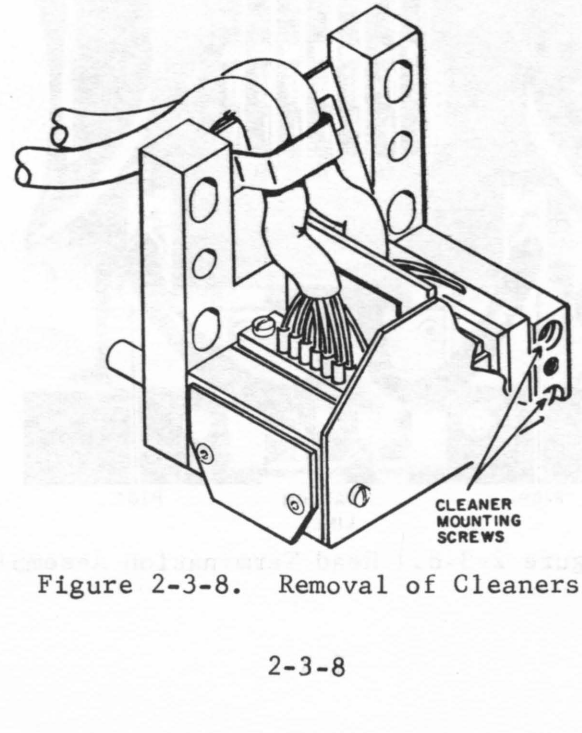


Figure 2-3-8. Removal of Cleaners

3. Attach the replacement cleaners to the head assembly but do not tighten screws.

CAUTION

Exercise care during the following step because too much pressure can damage the cleaner blades.

4. Place the entire head assembly on a surface plate (the side of the head alignment tool can be used). Insert 0.003 to 0.004-inch brass shims between the cleaners and the flat surface (Figure 2-3-9).

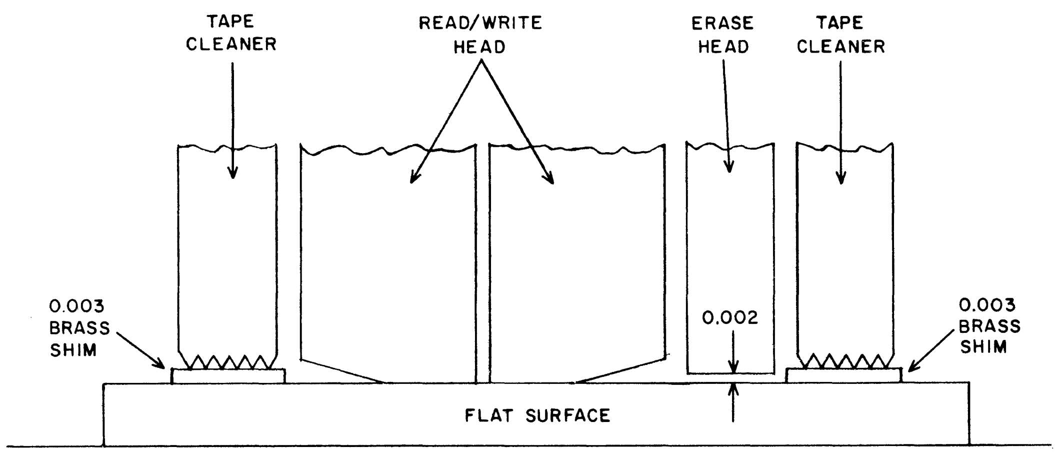


Figure 2-3-9. Tape Cleaner Adjustment

5. While holding the read/write head flat against the surface, gently press the cleaners down on the shim and tighten the mounting screws.

6. Recheck the cleaner clearance. The cleaner must be square with the head surface.

7. Remove the side cover from the old cleaner and position it on the replacement cleaner.

8. Reinstall the front shield with two screws.

LOAD POINT/END OF TAPE ASSEMBLY REPLACEMENT

1. Place the tool (part number 84052800) over the capstan wheels as shown in Figure 2-3-10.

2. Adjust eccentric with a socket head wrench until the top end of the tape sensor assembly touches the straight edge; that is, even with top of capstan wheels.

3. Connect P103 to connector panel.

NOTE

If brake pad is replaced, perform steps 1 and 2 except adjust eccentrics on brake block.

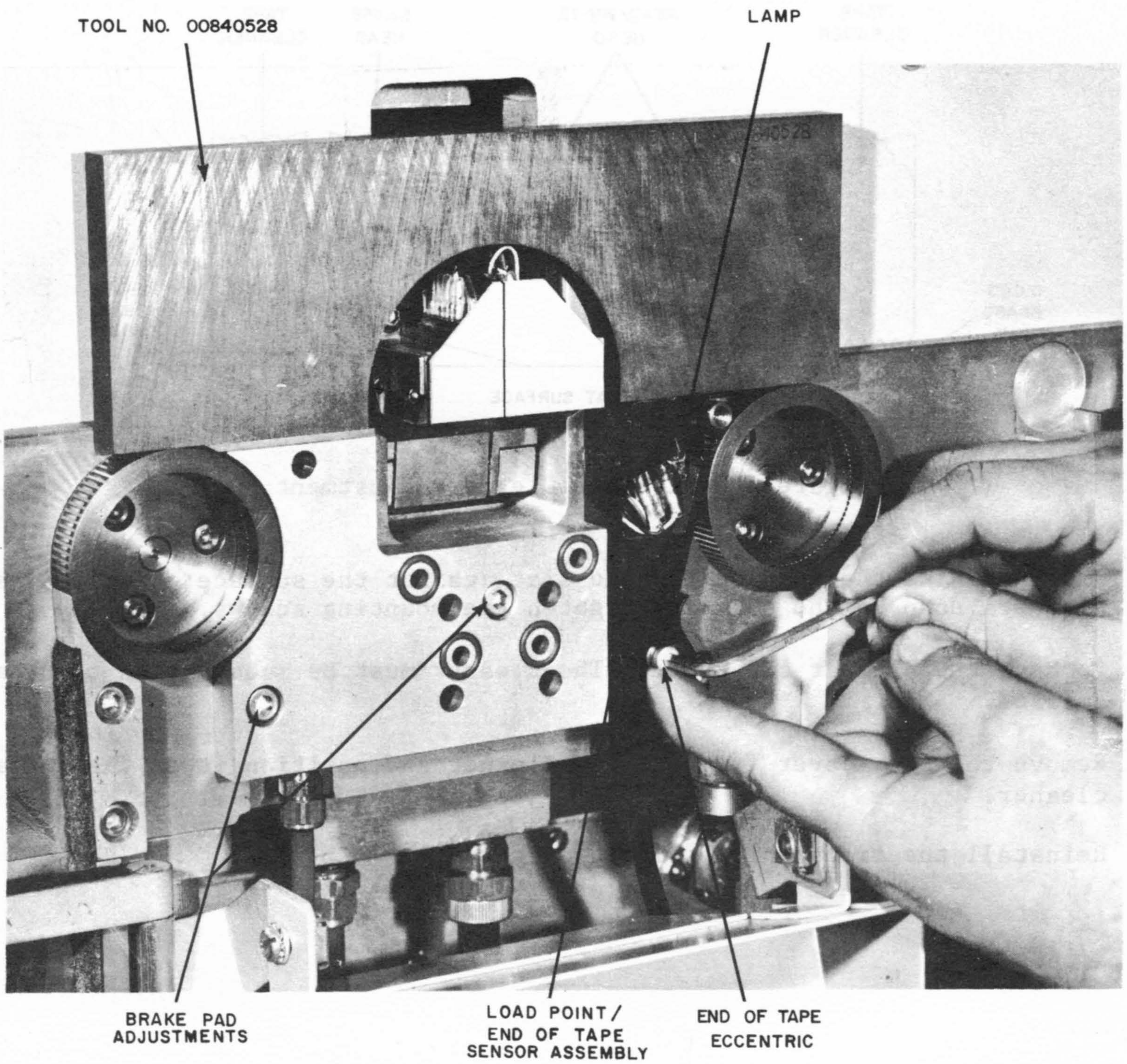


Figure 2-3-10. Load Point/End of Tape Sensor Assembly Adjustment.

CAPSTAN PLATE ASSEMBLY REPLACEMENT

1. Attach capstan plate with screws, but tighten only slightly.
2. Adjust plate so that capstan spins freely (check by spinning capstan first in one direction and then the other. After stopping, the capstan should back up slightly, indicating free rotation).
3. Tighten holding screws

CAPSTAN VALVES REPLACEMENT

1. Insure O-rings are in place.
2. Install forward and reverse capstan voice coils.
3. Connect P305 on top of reel drive chassis.

TACHOMETER REPLACEMENT

1. Attach tachometers using holding screws.
2. Check for freedom of rotation.
3. Connect P101 and P105.

MAGNETIC HEAD MECHANICAL ALIGNMENT

1. Place the head assembly in position on wobble plate (Figure 2-3-7) and insert the four head-mounting screws. Do not tighten the screws at this time.
2. Position the head alignment tool (part number 84011900) below the head assembly. This U-shaped jig fits in the tape channel between the sensor and load-point/end-of-tape brake block (Figure 2-3-7).
3. Insert the spacer blocks (part of head alignment tool), one on top of the other, between the head and jig.
4. Apply a light downward pressure at mounting block on the head assembly. Adjust the vertical head placement until the spacer blocks just pass evenly with binding.

5. Tighten the four mounting screws and repeat the clearance test.

6. Attach the two vacuum lines to the tape cleaners, connect P106 and P107 and secure the holding screws.

PRESSURE PAD ALIGNMENT

With the pressure pad assembly in the extended position, proceed with the alignment as follows:

1. Press the pad assembly down and remove the slotted pad from the mounting fork. Refer to Figure 2-3-11.

2. Loosen the three screws which hold the fork in place.

3. Replace the pad on fork.

4. Hold the pad firmly against the read/write head and tighten the lower fork-mounting screw.

5. Remove the pad and tighten the remaining screws.

6. With the pressure pad in an extended position, check that the pad is seated firmly against both sections of the read/write head. The pad should not contact the erase head or tape cleaners.

7. Adjust the two set-screws on the pressure pad to insure a snug fit in the pad fork lever. The set-screws should be adjusted to longitudinally position the "H" bar as near the read gap as possible and still maintain the pad air slots in the read and write gaps (Figure 2-3-12).

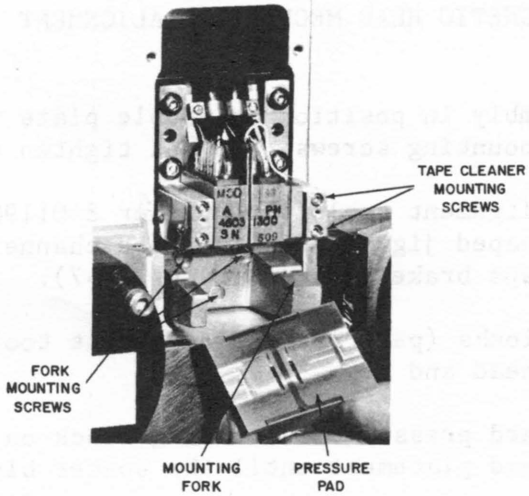


Figure 2-3-11. Pressure Pad Alignment

NOTE

Read crosstalk and noise superimposed on the read class A signal are functions of the longitudinal position of the pad. Therefore, it may be necessary to position the pad a second time if either of these discrepancies exist.

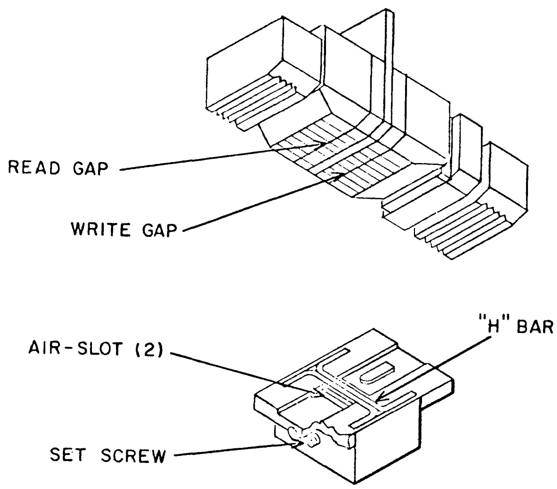


Figure 2-3-12. Pressure Pad Positioning

REEL HUB REPLACEMENT OR ALIGNMENT

1. Turn reel knob counterclockwise and remove it from the reel hub. Refer to Figure 2-3-13.

NOTE

Be careful not to lose the ball bearing located on the reel knob shaft.

2. Remove the ball bearing, compression clamp, and neoprene rubber ring from the reel hub.

3. Loosen the three cap screws securing the reel hub to the reel motor ring clamp.

4. Place one end of a 3/8-inch-diameter rod on the head of each socket head cap screw. Lightly tap the other end of the rod with a hammer to free the reel clamp from the reel motor shaft.

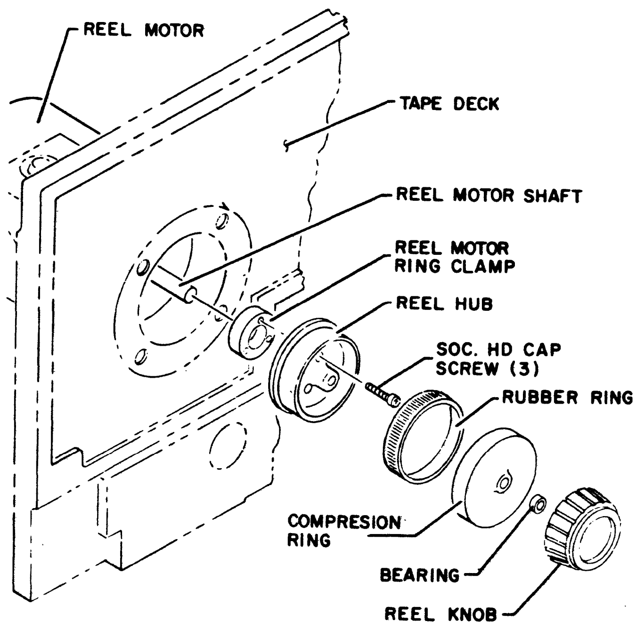


Figure 2-3-13. Reel Hub Assembly

5. Remove the reel hub from the reel motor with a reel hub removal tool, part number 84052900. Refer to Figure 2-3-14.

6. Install a replacement hub on the motor shaft and tighten the three cap screws by hand securing the hub to the shaft.

NOTE

The hub must slide freely on the motor shaft.

7. Insert the reel hub removal tool into the reel hub. Turn the tool clockwise until the end of tool touches the end of motor shaft.

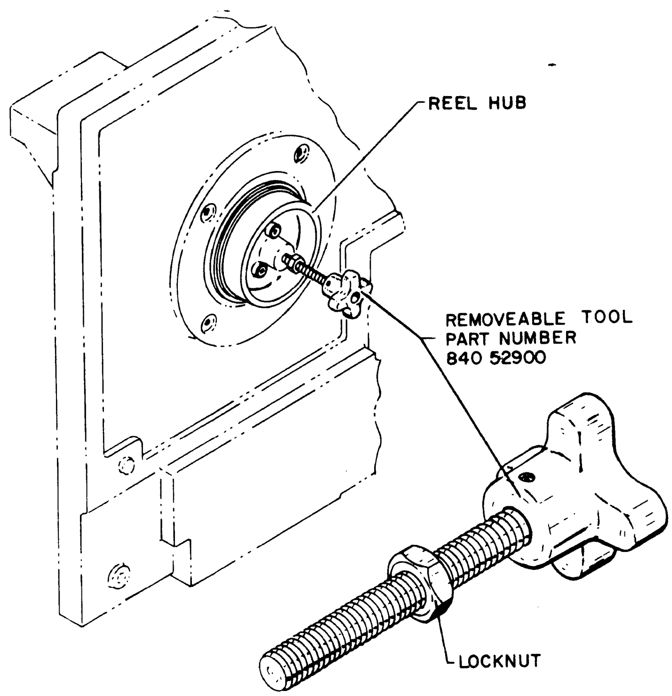


Figure 2-3-14. Reel Hub Removal Tool

8. Align the reel hub with the front machined surface of the tape deck (Figure 2-3-15).

NOTE

The shoulder of the hub (indicating surface) fits between the go, no-go surface of the tool (part number 87109200).

9. Adjust the hub position with a reel hub removal tool. Tighten the removal tool lock-nut to finger tightness to prevent accidentally knocking tool out of alignment.

10. Rotate the motor shaft by hand and check the alignment at a minimum of three points on the hub.

11. Set the tip of the dial indicator on the indicating surface of the reel (Figure 2-3-16) and rotate the hub.

12. Be sure the mounting screws are snug and the reel hub is in position.

13. A total indicator reading (TIR) or 0.002 inch maximum should be obtained. Adjust the hub until this tolerance is met. If the indicator reading is

positive, tighten the screw on the side opposite the indicator needle. When indicator reading is negative, rotate the capstan 180° and tighten the screw opposite the indicator needle.

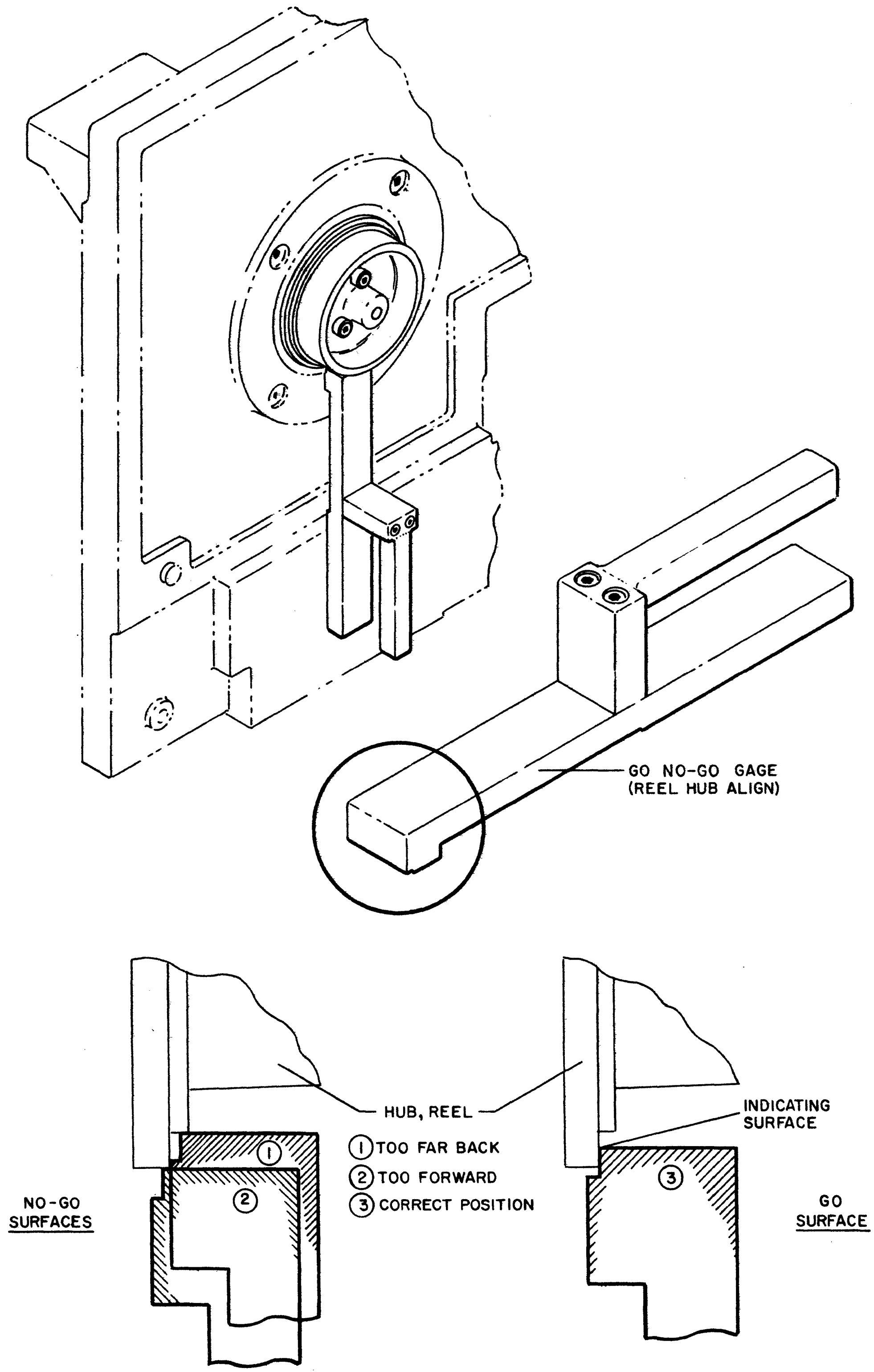


Figure 2-3-15. Reel Alignment Tool

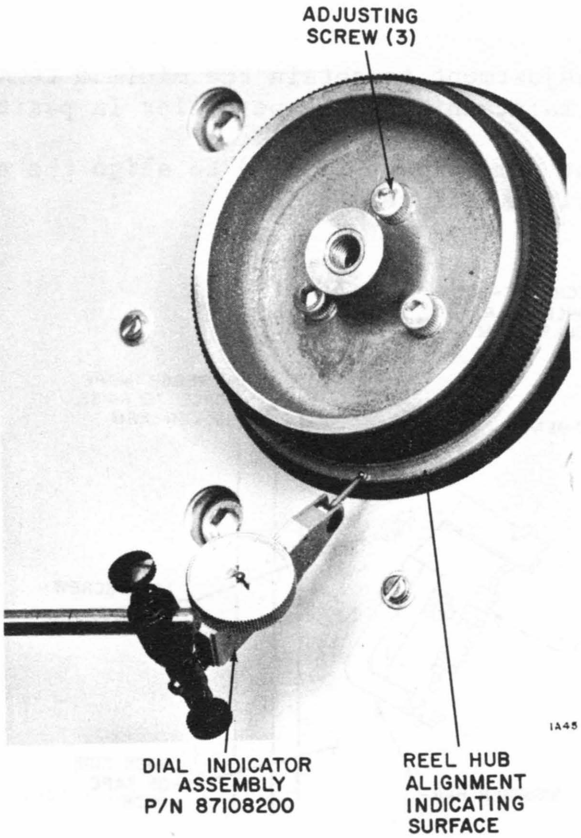


Figure 2-3-16. Reel Hub Alignment

CAUTION

Tighten all adjustment screws after the adjustment. If they are not tight, the reel and hub might work loose during operation, causing serious damage.

14. Install the neoprene rubber ring, compression ring, and ball bearing on the reel knob shaft.
15. Install the reel knob and turn it clockwise to tighten.

TAPE ROLLER ADJUSTMENT

This procedure is an adjustment to obtain the minimum tension necessary to raise the roller arm, while maintaining the tape roller in position for loading tape.

1. Move the adjustment arm (Figure 2-3-17) to align the spring and snubber bar to a common centerline (Figure 2-3-18).

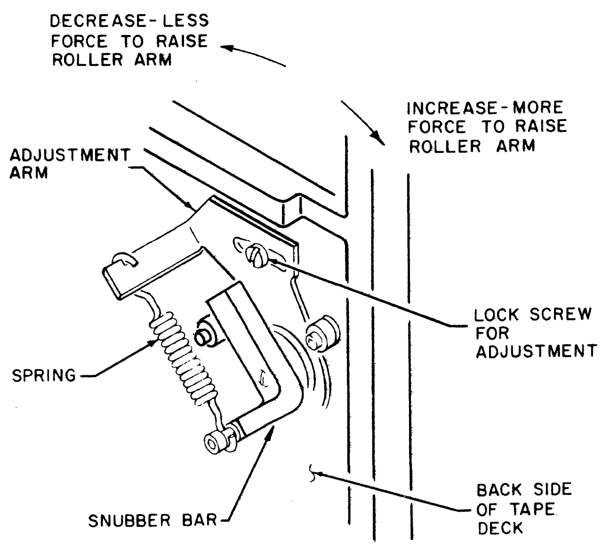


Figure 2-3-17. Tape Roller Arm Adjustment

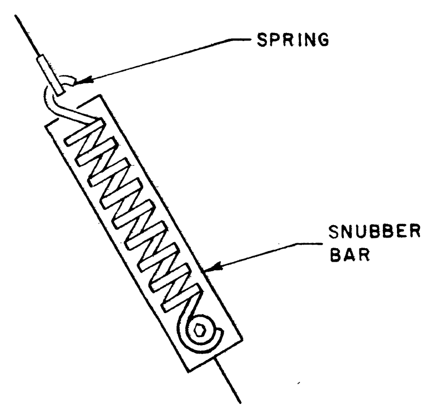


Figure 2-3-18. Spring and Snubber Bar Alignment

2. If proper tension is not obtained by step 1, move the adjustment arm to increase or decrease tension as required.

NOTE

This procedure is identical for both tape roller arms.

Align the tape path of the tape roller assembly as follows:

1. Place the tape alignment tool, part number 84026300, against the machined surface of the tape deck. Refer to Figure 2-3-19.

2. Add shims as required to obtain the 0.017-inch dimension shown in Figure 2-3-20.

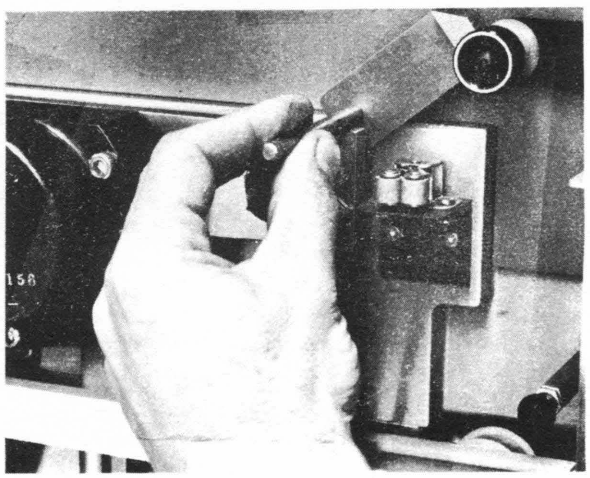


Figure 2-3-19. Tape Path Alignment

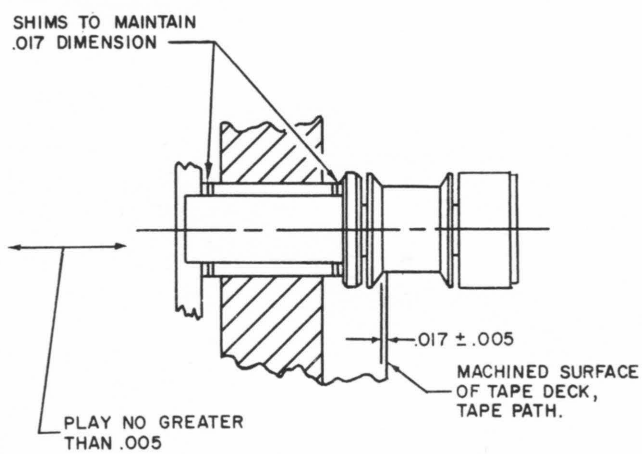


Figure 2-3-20. Tape Roller Assembly

CHAPTER IV

POWER SUPPLY

CHAPTER IV

POWER SUPPLY

The primary power is converted to ac and dc for control and operation of the magnetic transport. The distribution of power throughout the transport is in a logical sequence.

I. 208 vac, 3Ø, 60/50 cps is applied to the power supply chassis.

II. Main Power circuit is ON causing neon lamp DS01 to illuminate.

III. Relay Power circuit breaker CB10 is ON, and the momentary closed Power On switch on the maintenance panel is held on for 2 seconds, power is applied through transformer T2 to energize K1 and K6. The power is then:

A. Applied through the closed contacts of K1 and Cooling Motors circuit breaker CB8 so that power is applied to the cabinet blowers.

B. Applied through the closed contacts of K1 so that when primary dc power circuit breaker CB4 is closed, power is applied to the primary of transformer T1. Refer to the "power on sequence" diagram. The secondary voltage is:

(1) Supplied as 40 vac, through the valve panel to energize the photocell lamp in the tape loop boxes, and the load point/end of tape lamps on the tape deck.

(2) Rectified in a full wave bridge network. The $\pm$ 20 vdc outputs are applied to their respective circuit breakers.

(a) The -20 vdc is applied through -20 vdc power circuit breaker CB3 to:

(1) The reel drive motor as field supply.

(2) One side of relays K5, K4, K7, and K3.

(3) To Light 1, Light 2, and File protect solenoids and to the Loop Fault Bypass, Pad Extend, and Tape Scraper as power in the valve panel.

(4) The logic circuit as power.

(5) A capacitive charging network which provides a 1 second clear pulse to clear the Ready FF, the Rewind Unload FF, the Extend Pad FF, the Set Loops FF and to set the Unload FF. Refer to the power on sequence diagram.

(a) Setting the Unload FF provides power to illuminate the Unload lamp.

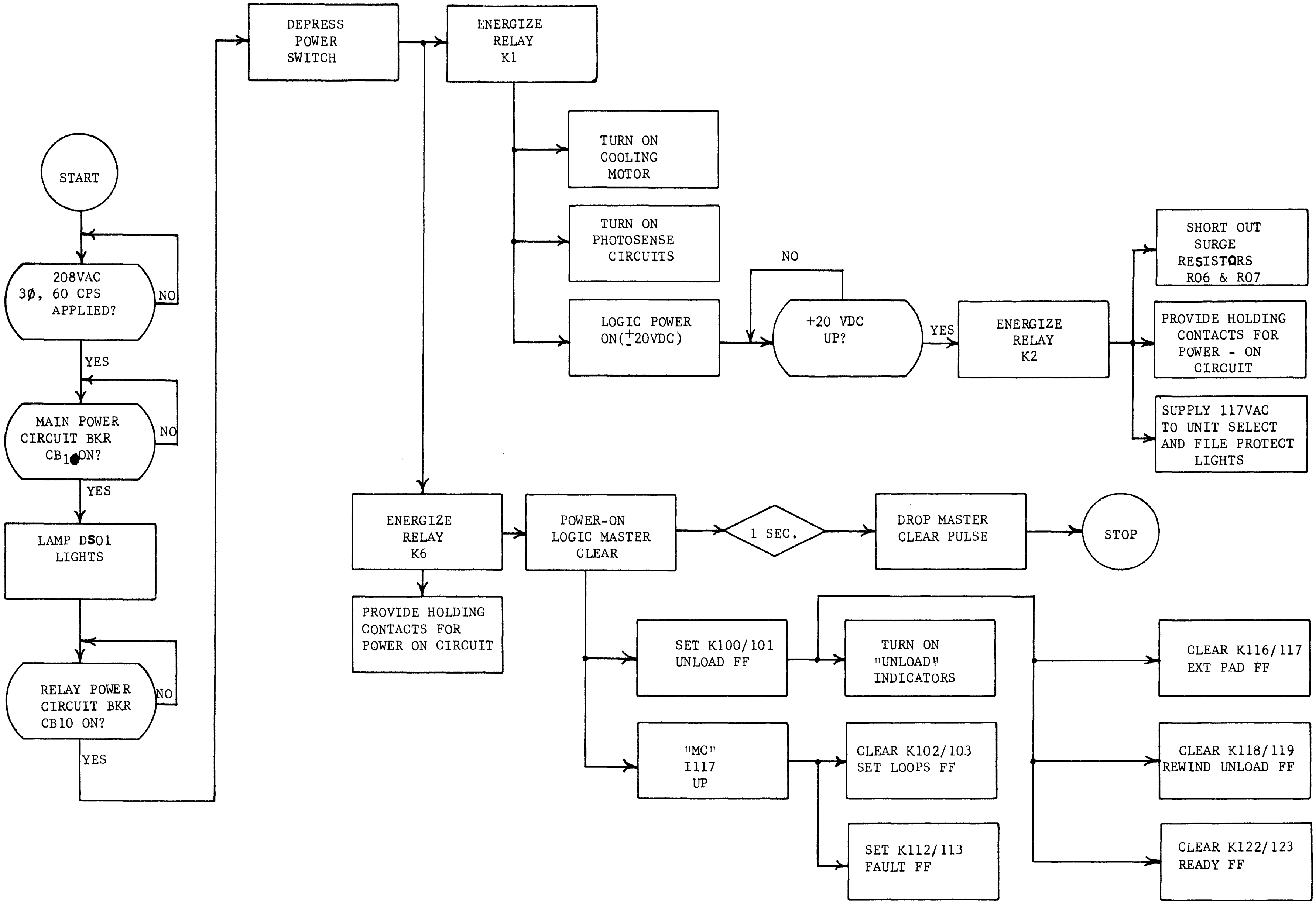
(b) Clearing the Set Loops FF provides power to energize relay K4 when a load sequence is in progress. Consequently, power is applied through closed take-up reel armature circuit breaker CB7 and supply reel armature CB6 to their respective drive motors.

(b) When +20V dc power circuit breaker CB2 is closed, power is applied to:

(1) Energize relay K2, providing holding power for K1 and K6, and make available the power to illuminate light #1/Light 2 and the File Protect light. Refer to the power on sequence diagram.

(2) The logic circuit as power.

(3) The Tachometer as power.


START
208VAC 3Ø, 60 CPS APPLIED?
NO
YES
MAIN POWER CIRCUIT BKR CB1 ON?
NO
YES
LAMP DS01 LIGHTS
RELAY POWER CIRCUIT BKR CB10 ON?
NO
YES
DEPRESS POWER SWITCH
ENERGIZE RELAY K1
TURN ON COOLING MOTOR
TURN ON PHOTOSENSE CIRCUITS
LOGIC POWER ON(±20VDC)
NO
+20 VDC UP?
YES
ENERGIZE RELAY K2
SHORT OUT SURGE RESISTORS R06 & R07
PROVIDE HOLDING CONTACTS FOR POWER - ON CIRCUIT
SUPPLY 117VAC TO UNIT SELECT AND FILE PROTECT LIGHTS
ENERGIZE RELAY K6
PROVIDE HOLDING CONTACTS FOR POWER ON CIRCUIT
POWER-ON LOGIC MASTER CLEAR
1 SEC.
DROP MASTER CLEAR PULSE
STOP
SET K100/101 UNLOAD FF
TURN ON "UNLOAD" INDICATORS
"MC" I117 UP
CLEAR K102/103 SET LOOPS FF
SET K112/113 FAULT FF
CLEAR K116/117 EXT PAD FF
CLEAR K118/119 REWIND UNLOAD FF
CLEAR K122/123 READY FF

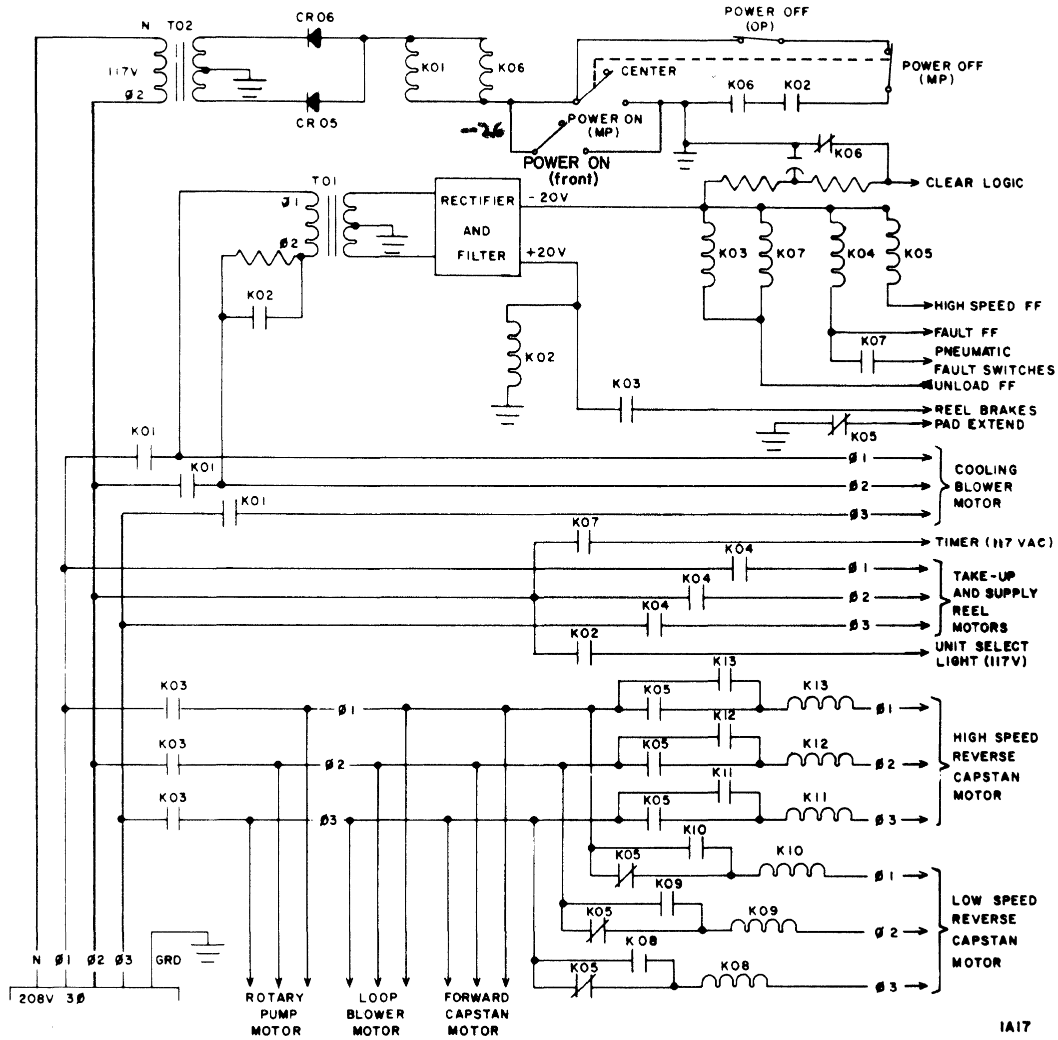


Figure 2-4-1. Power Supply, Simplified Schematic

CHAPTER V

CONTROL LOGIC DESCRIPTION

CHAPTER V

CONTROL LOGIC DESCRIPTION

MOTION AND DRIVE CONTROL LOGIC

The motion select circuit determines the direction tape is to be moved. After direction is selected, tape motion is controlled by the capstan drive and brake control circuit which applies pressure or vacuum to the capstans and vacuum to the pneumatic brake port.

MOTION SELECT CIRCUIT

Tape direction is determined by the Forward and Reverse FFs. Because the forward and reverse circuits are similar in design and function, only the forward circuit (Figure 2-5-1) is discussed.

The Forward FF is set when:

1. Forward operation is selected from TCU, or

2. Forward operation is selected by pressing the Forward switch on operator's or maintenance panels, or

3. It is necessary to search for load point by moving tape forward. This occurs when a rewind operation is terminated or during a load tape operation.

The following actions occur when the Forward FF is set:

1. Forward indicators (MP and OP) are turned on.

2. I407 produces a "0" output for 2 ms which is applied to Y402 in the forward capstan drive circuit. This allows 2 amperes of current to by pass R204 for 2 ms to reduce actuation time of the pneumatic valve coil.

3. Set output from the Forward FF is sent to emitter follower (EF) cards in the capstan drive circuit. The capstan drive circuit applies vacuum to the forward capstan. Tape is therefore moved in the forward direction.

4. A busy signal is returned to the TCU indicating that tape motion is in progress. This signal stays up approximately 5 ms after the Motion FF clears (allowing time to stop motion).

The Motion FFs are cleared if any of the following conditions exists:

1. Forward command from TCU is dropped while the write operation is still enabled.

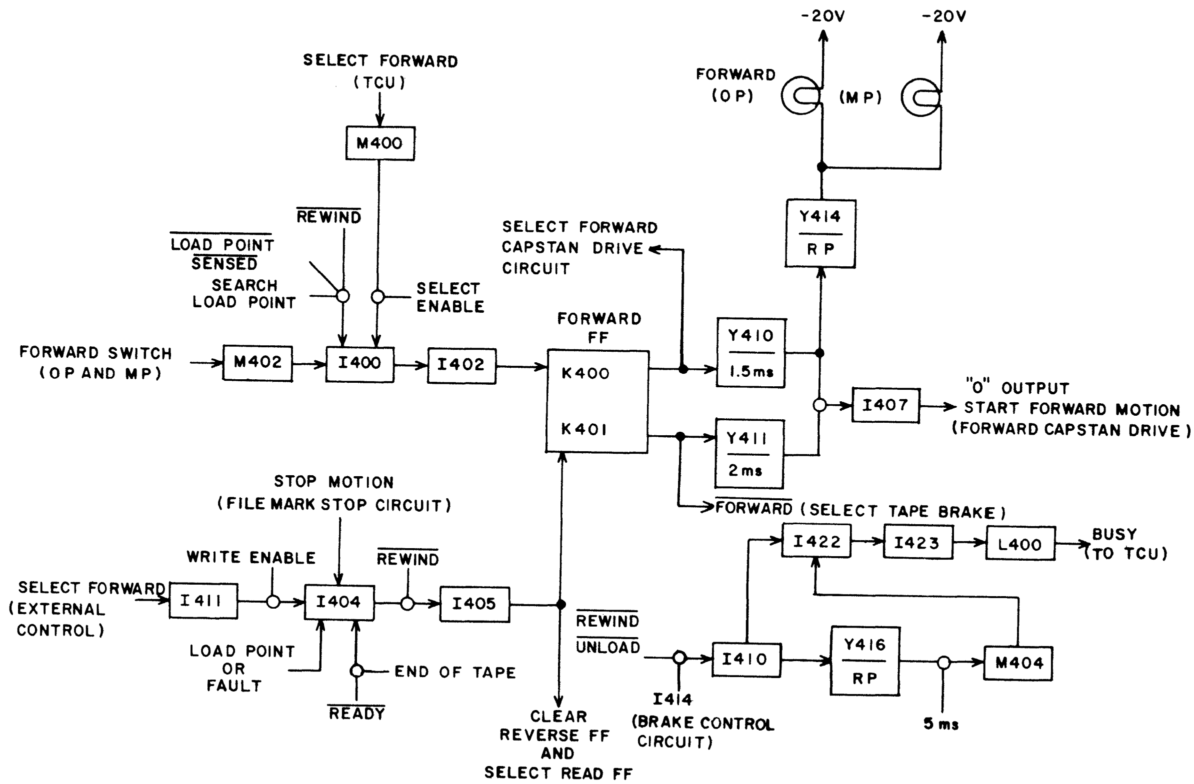


Figure 2-5-1. Motion Select Circuit

2. Operation is under manual control (not ready), and end of tape is detected while tape is moving forward.

3. Load point is sensed or fault detected.

4. File mark stop circuit produces a stop signal.

When the Motion FFs are cleared, the Select Read FF is also cleared. Therefore, a new select read signal must accompany or precede every new motion signal from the TCU.

When cleared, the Motion FFs:

1. Turn off Motion indicators on the operator's and maintenance panels.

2. Stop tape motion by removing vacuum to capstan and applying vacuum to brake port.

3. Drop busy signal to TCU after a 5ms delay.

CAPSTAN AND BRAKE CONTROL CIRCUITS

The motion select circuit determines the direction tape is to be moved. After direction is selected, tape motion is controlled by the capstan and brake control circuits (Figure 2-5-2) which apply pressure or vacuum to the capstans and pneumatic brake port. In the drive condition, vacuum is applied to the forward or reverse capstan while vacuum is removed from the brake port. In this case, the tape is held against the rotating capstan and moved across the read/write heads. In the clear or nondrive condition, vacuum is applied to the brake port while pressure is applied to both capstans. The tape is, in this case, held against the brake port but separated from both rotating capstans.

The capstan and brake control circuits (Figure 2-5-2) energize three two-terminal valve coils in response to logic inputs from the motion select and local control circuits. The valve coils then allow vacuum to be valved to the brake port and vacuum or pressure to the appropriate capstan.

NOTE

Positive pressure is never applied to the brake port.

The forward capstan circuit applies vacuum to the forward capstan when I409 receives a "1" input. Conversely, pressure is applied to the forward capstan when I409 receives a "0" input. A "1" input is applied to I409 when:

1. Forward motion is selected (Forward FF set and Reverse FF cleared).

2. Reverse selection is dropped (Reverse FF switched from set to clear state) and a high speed rewind operation is not selected. This combination of terms provides a 1.5ms input pulse to I409 and allows tape to be driven forward for 1.5ms after a reverse selection is dropped. This procedure serves to reduce stop time and distance during a low speed reverse operation.

The reverse capstan circuit applies vacuum to the reverse capstan when I406 receives a "1" input. A "0" input causes pressure to be applied to the reverse capstan. A "1" input is applied to I406 when:

1. Reverse motion is selected (Reverse FF set and Forward FF cleared).

2. Forward selection is dropped (Forward FF switched from set to clear state) and a high speed rewind operation is not selected. This input provides a 1.5ms pulse to I406 and allows tape to be driven in reverse for 1.5ms after the forward selection is dropped. This procedure serves to reduce stop time and distance during a forward operation.

3. Rewind is in progress, left top photocell off, and right bottom photocell on. This condition indicates that during a rewind operation, tape can be driven in reverse without causing a fault. Because the reverse capstan could out-run the reel drives during a high speed rewind and cause a pneumatic fault, the position of the tape loops is constantly monitored and specifies when the reverse capstan is allowed to drive tape.

The tape brake applies vacuum to the brake port when I424 produces a "0" output (Figure 2-5-2). A "1" output from this term causes vacuum to be removed from the brake port. I424 produces a "0" output only when both the Forward and Reverse FFs are clear and a rewind or rewind unload operation is not in progress.

The capstan and brake port valve coils are driven by similar circuits. The circuit that controls the direction and magnitude of current in the forward coil requires that the current direction be reversed to switch from pressure to vacuum or vice versa. To reduce actuation time, the pneumatic valve coil also requires 2 amperes initial current in the new direction for 2ms. One ampere is sufficient to maintain the valve in the steady state position until the next change.

The switching circuit that selects the direction of current in L01 is called an H switch. The switches are composed of transistors with heat sinks (Q212 through Q215) and are located in the four legs of the H configuration. The load (L01) is at the crossbar of the H configuration. At any given instant, two of the four transistors are switched off. The on transistors occupy diagonally opposite legs in the H configuration. Q213 and Q215 are switched on for a forward operation, connecting vacuum to the rotating capstan causing it to drive tape. Q212 and Q214 are switched on for a reverse or stop operation, connecting pressure to the rotating capstan and preventing contact with the tape.

If the emitter followers (EF's) are removed from the circuit, resistors R01 through R05 provide bias for Q211 through Q215. One EF operates each pair of switches in the H configuration. Resistors Rx and Ry (selected for each circuit) in the EF card prevent overdrive of Q212 and Q213. This allows the EF to drive both switching transistors in parallel even though the emitter reference voltages are different. The values of Rx and Ry are chosen to provide approximately equal drive to both switching transistors.

The magnitude of current in the pneumatic valve coil is determined by the power supply voltage and the total effective series resistance in the circuit. The power supply voltage is fixed at 20v. Total circuit resistance during the initial high pulse, excluding the saturation resistance of switching transistors, is about 8 ohms (L01 and R202). After the current is reduced, the total circuit resistance is about 18 ohms (L01, R204, and R202).

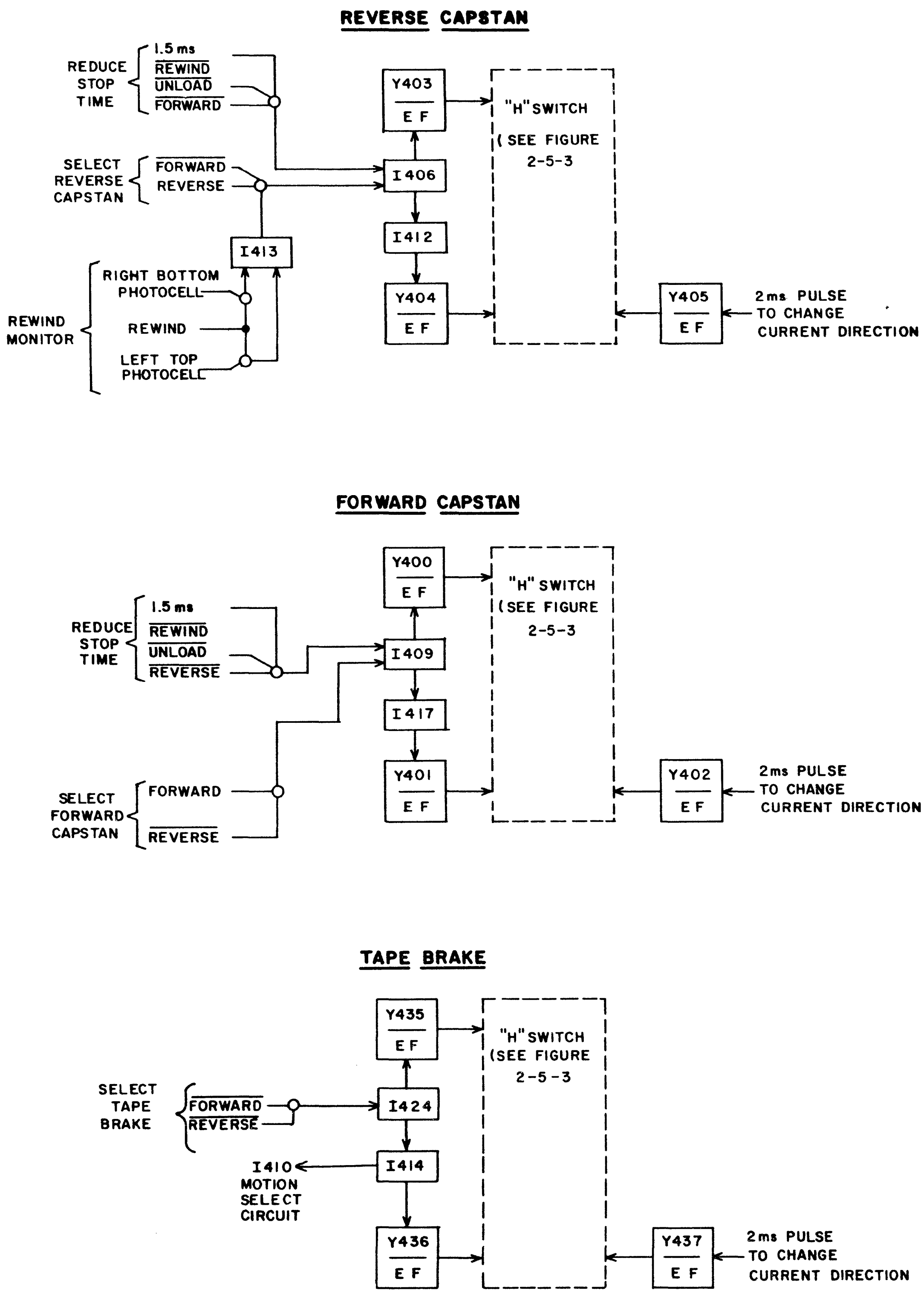


Figure 2-5-2. Capstan and Brake Control Circuit

Effective resistance of the switching transistors is less than 1 ohm for either level of current. The EF driving Q211 drives only Q211. The emitter voltages of Q212, Q213, and Q211 are approximately the same during the high current level; each of the conducting transistors has approximately the same drive. The change in emitter voltages of Q213 and Q212 at the lower current level causes a corresponding decrease in the drive current of Q212 or Q213. Transistor Q211 is turned off at the lower current level.

The use of the series resistance (R204 and R202) in this circuit prevents excessive current flow and avalanche failure of several semiconductors due to small delays in turn-off of Q212 through Q215. Fuse F01 prevents a sustained high current level from damaging L01.

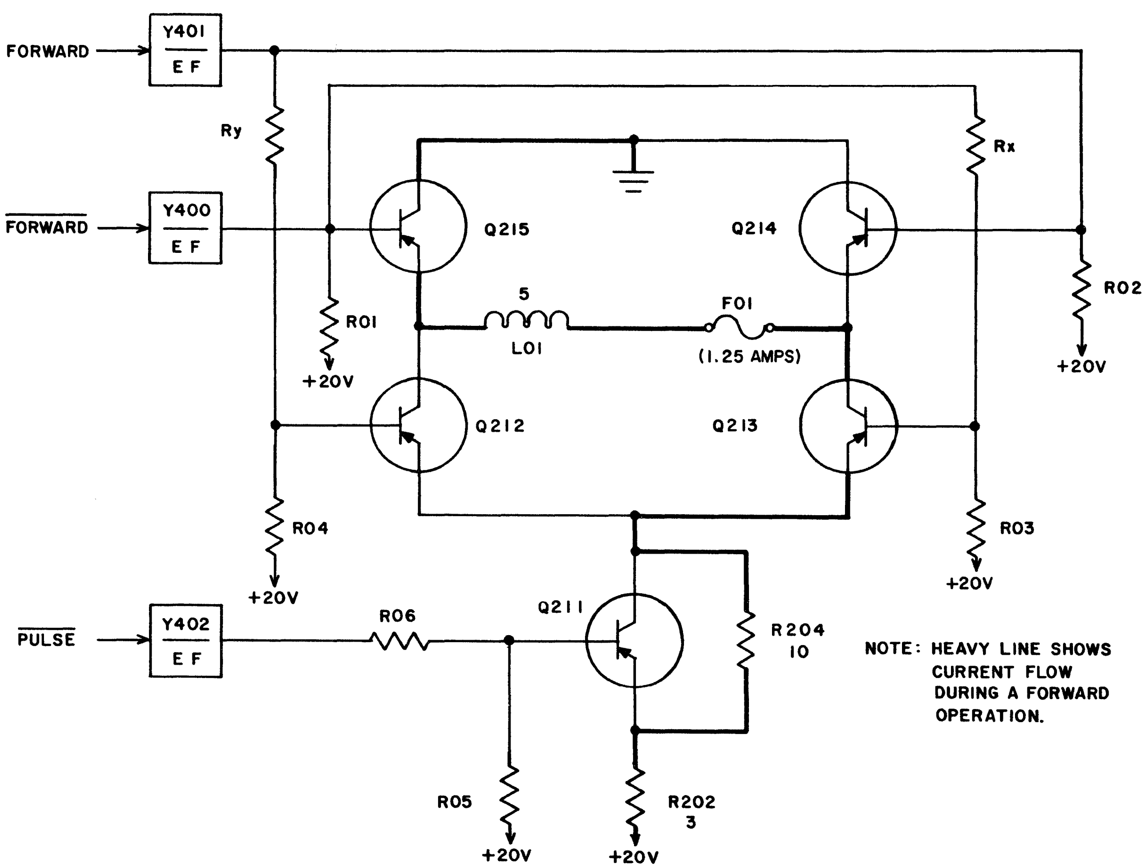


Figure 2-5-3. Forward "H" Switch

SERVO DRIVE CONTROL LOGIC

The servo drive control circuits monitor and control the length of the tape loop in each of the vacuum columns. The output from this circuit is applied to the reel motor drive circuit, which provides the output power necessary to operate the motors and brakes.

The servo drive control logic is divided into two sections:

Photosense circuits	Determine the position of tape in the vacuum storage columns and, based upon this information, specify which reel is to be braked or the direction it is to be driven.
Tachometer circuits	Compare tape speed with a preset value. Enable drive pulses to be applied to the reel motor drive circuits only when reel speed is less than the preset value and photosense circuits specify drive direction.

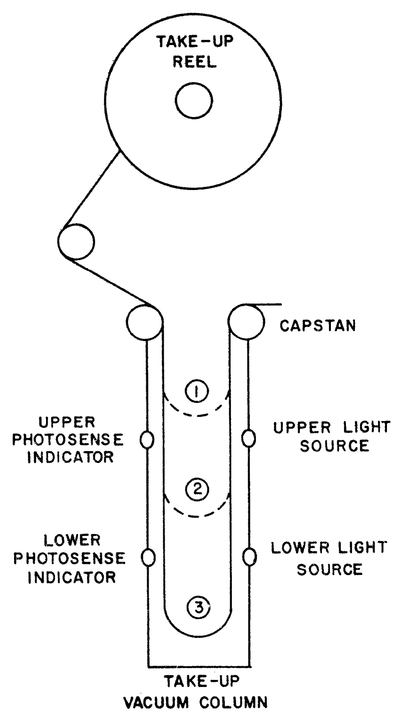


Figure 2-5-4. Loop Sensing in Vacuum Columns

The following paragraphs describe the operation of the servo drive control logic. Because the servo control logic is similar in design and function for both the take-up and supply reels, only the take-up circuits are discussed.

PHOTOSENSE CIRCUITS

Each vacuum column is equipped with an upper and lower photocell network. The photocells, when illuminated, indicate that the tape loop is above the respective photocell; that is, tape has not been placed between the photocell and its light source (Figure 2-5-4).

If the tape loop is in position 1, both the upper and lower photocells are illuminated. This indicates that more tape must be supplied to the column by the take-up reel (drive reel CCW).

If the tape loop is in position 2, only the lower photocell is illuminated. This indicates that the take-up reel must be braked to maintain the tape loop in this position.

If the tape loop is in position 3, both the upper and lower photocells are off. This indicates that tape must be removed from the column by the take-up reel (drive reel CW).

The output from the photocells are amplified and applied through the inverter circuits (Figure 2-5-5) to the Brake, CW, and CCW relay pullers. These elements, in response to the input from the photocell amplifiers, determine whether the take-up reel is to be braked or driven in the CW or CCW direction (Table 3).

Note the following points concerning the photosense circuit:

1. A fault condition results in an immediate "0" output from I315 and the take-up reel is immediately braked.

2. During a load tape operation, the AND input to the CCW relay puller is disabled. Thus, the reel cannot be driven CCW until tape is loaded. This precaution eliminates the possibility of all tape being unwound from the take-up reel into the vacuum column during the load tape operation.

3. During any operation involving high speed rewind, the output from I315 is a steady "1" and the reel is not braked.

Figure 2-5-6 illustrates what actually happens in the reel drive chassis when the reel is to be driven clockwise, counter clockwise, or braked.

Rectification of 3Ø Power is accomplished by switching 3 SCR's into the circuit when it is necessary to go CW or CCW.

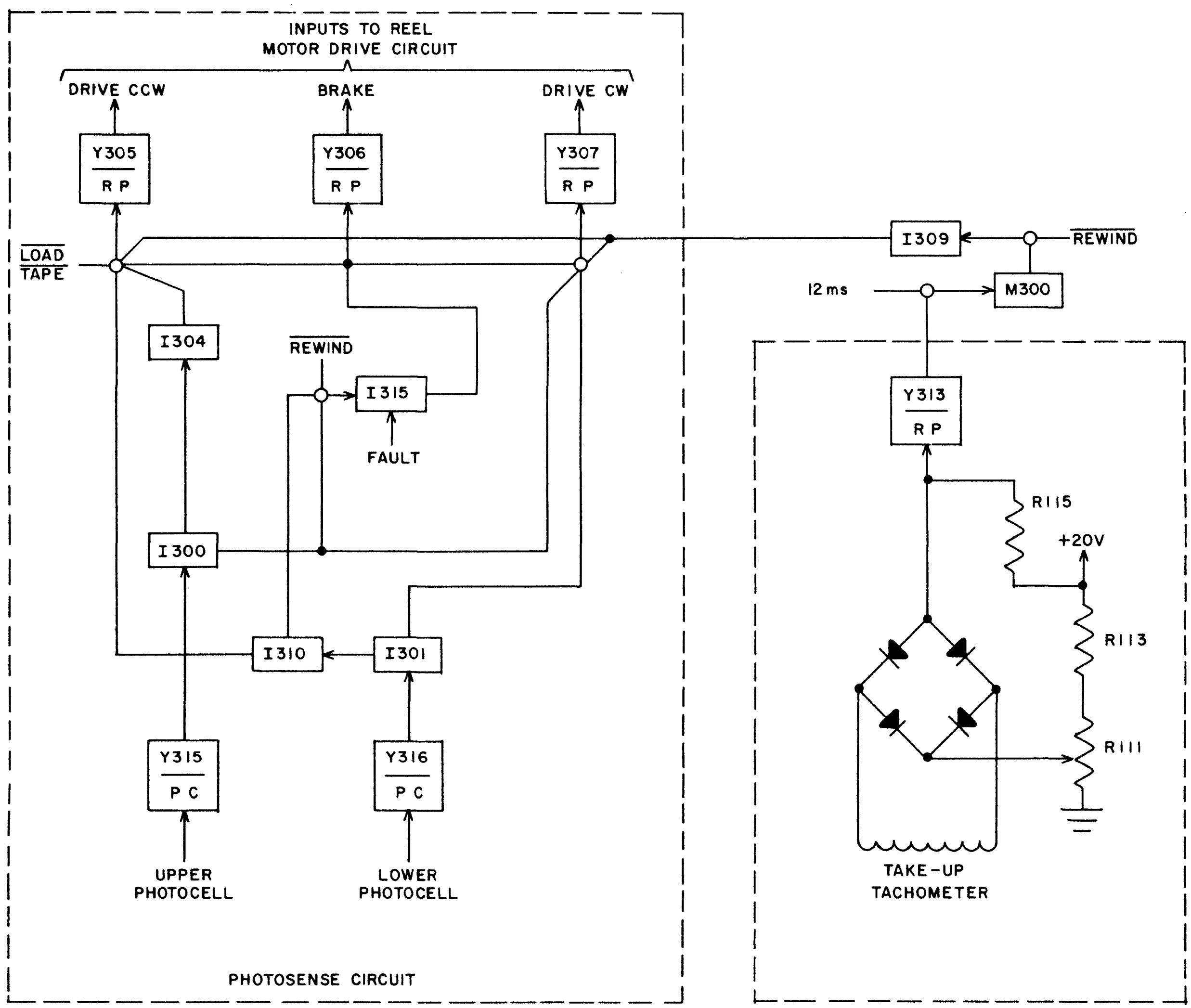


Figure 2-5-5. Servo Drive Control Circuits (Take-Up Reel)

TABLE 2-5-1. PHOTOSENSE CIRCUIT DESCRIPTION

CONDITION	ACTION	RESULT
Both photocells on	"1" input to brake relay puller (Y306) "1" input to CCW relay puller (Y305) "0" input to CW relay puller (Y307)	No brake take-up reel* Drive take-up reel CCW* No drive take-up reel CW*
Upper photocell off Lower photocell on (Not Rewind)	"0" input to brake relay puller (Y306) "0" input to CCW relay puller (Y305) "0" input to CW relay puller (Y307)	Brake take-up reel No drive take-up reel CCW No drive take-up reel CW
Both photocells off	"1" input to brake relay puller (Y306) "0" input to CCW relay puller (Y305) "1" input to CW relay puller (Y307)	No brake take-up reel No drive take-up reel CCW Drive take-up reel CW

*Brake relay is de-energized to brake
Drive relays are energized to drive

1 0 to Y305 NO DRIVE CCW
1 to Y307 DRIVE CW

2 NO DRIVE BRAKE
CW-CCW

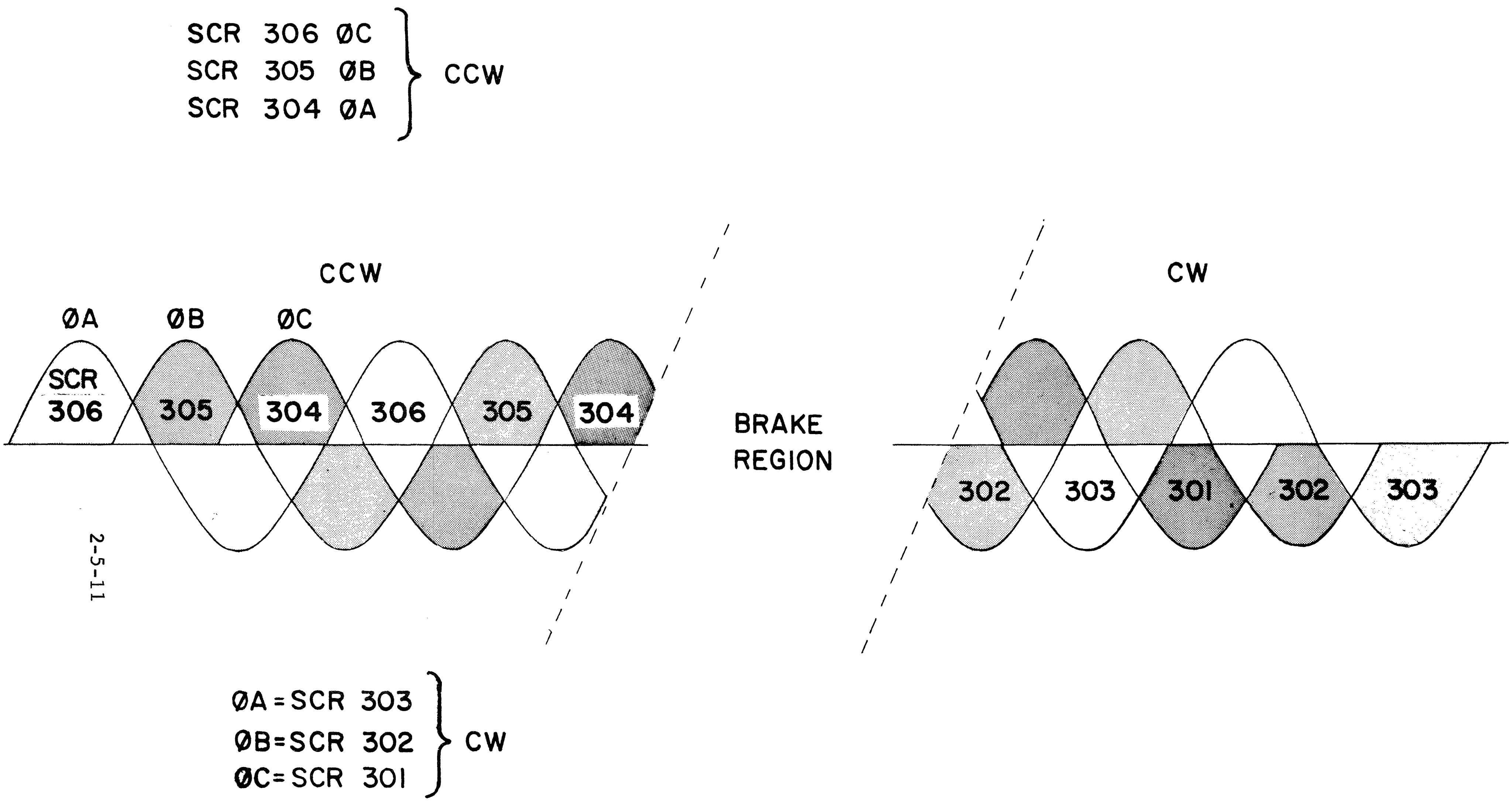
3 1 DRIVES SUPPLY REEL CCW
NO DRIVE CW

TACHOMETER CIRCUIT

The tachometer circuit (Figure 2-5-5) disables the application of drive pulses to the reel motor circuit when tape speed into or out of the vacuum storage columns exceeds capstan speed by approximately 10 inches per second. The maximum speed of the reel motor is therefore limited in order to reduce the time required to stop the reel.

The tachometer is an ac generator whose output voltage is directly proportional to the tape speed into or out of the columns. As tape speed drops below the capstan speed of 150 ips, frequency and amplitude are both reduced accordingly. As tape speed is increased, amplitude and frequency increase proportionately.

The bridge circuit full-wave rectifies the output signal from the tachometer allowing only negative signals to be applied as inputs to the relay puller (Y313). The input circuit of Y313 is positively biased due to the resistor network composed of R111, R113, and R115. If the tape speed into or out of the vacuum column is less than the speed of the established bias level, the relay puller has a "0" input and the output from M300 switches to a "0" after 12 ms because of the delay between the relay puller and the M card. Therefore, after 12 ms, I309 produces a drive enable pulse.



REEL DRIVE CONTROL

Figure 2-5-6. Reel Drive Control

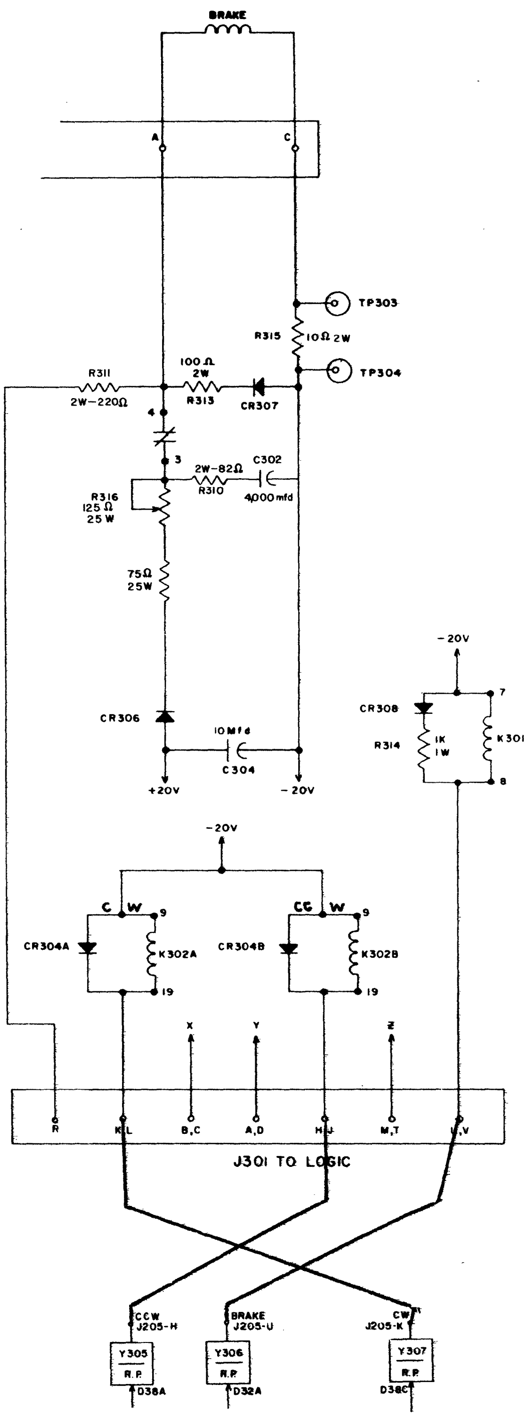


Figure 2-5-7. Reel Drive Chassis

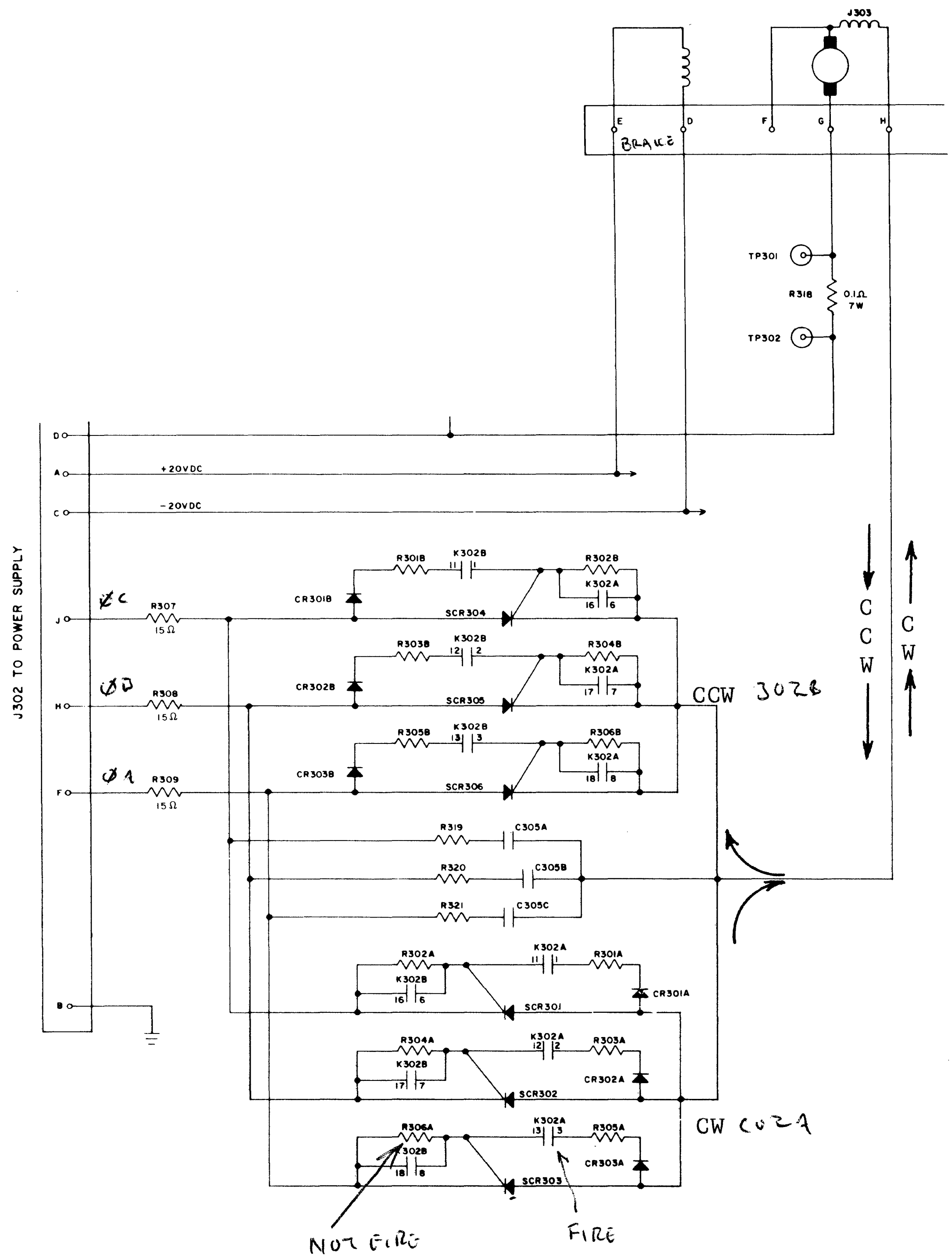


Figure 2-5-8. **Reel Drive Chassis**
3Ø Power Rectification

If tape speed is greater than capstan speed, the relay puller receives a "1" input from the tachometer circuit and M300 immediately produces a "1" output. In this case I309 does not produce a drive enable pulse until the input to Y313 reverts to "0" and remains such for at least 12 ms.

The tachometers operate only during low speed (150 ips) forward and reverse operations. During a high speed rewind operation, the AND input to I309 is disabled. The result is a steady drive enable pulse from I309. The rate at which drive pulses are applied to the reel motors is dependent solely on the photosense circuits.

LOCAL CONTROL

This section of the logic consists of all sense circuits as well as those control circuits which are activated by manual switches and/or signals from the tape control unit. The circuits are discussed in the following order: sense, pad extend, load tape, rewind, and rewind unload. Operational flow charts which describe the load tape, rewind, and rewind unload procedures are included.

SENSE CIRCUITS

Ready

The Ready FF (K 122/123), when set, indicates that the tape is under external control (ready). A not condition (Ready FF cleared) indicates that the tape unit is under manual control and cannot communicate with the TCU.

The Ready FF (Figure 2-5-9) is set by pressing the Ready switch on the operator's panel. When set, the following actions occur:

1. Ready indicators on operator's panel and maintenance panel turn on.

2. A ready signal is sent to the TCU. This indicates that the 606 is under control of the TCU and no fault is present. (If a power failure occurs, the Ready relay (K201) is de-energized allowing a not ready signal to be sent to the TCU.)

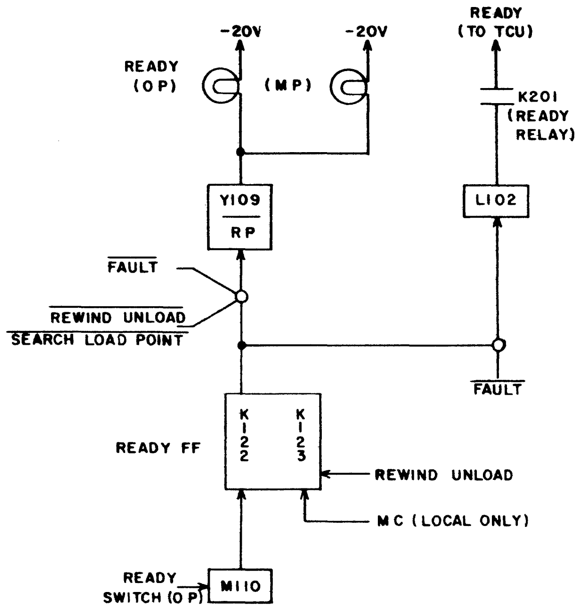


Figure 2-5-9. Ready Circuit

End of Tape (EOT)

Detecting the end of tape reflective marker, when tape is moving forward, sets the Sense End of Tape FF (K 120/121). The Sense End of Tape FF (Figure 2-5-10), when set, initiates the following.

1. Turns on the EOT indicator on the maintenance panel.

2. Returns an end of tape signal to the TCU indicating that the reflective marker has been located.

3. Stops tape motion by clearing the Motion FF's only if unit is under manual control (refer to motion select logic). If unit is under external control, motion continues until stopped by either a load point marker, fault, stop signal from file mark stop circuit, or by dropping the forward select while a write operation is still selected.

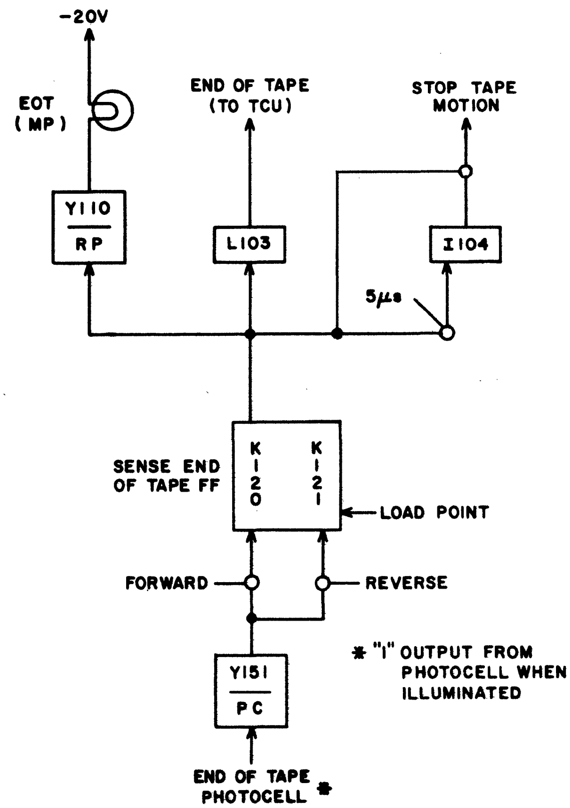


Figure 2-5-10. Sense End of Tape Circuit

The Sense End of Tape FF, once set, remains set until the EOT marker is sensed in the reverse direction or load point marker is detected. Therefore, if when under external control the EOT marker is sensed, the unit need not be stopped immediately.

The operation in progress can be completed even though the tape moves further from the marker (FF remains set). The TCU always knows which side of the marker the tape is on.

The Sense End of Tape FF can only be cleared by sensing the EOT marker in the reverse direction or by sensing a load point marker. This could occur if more than one load point is used on a reel of tape. Note that tape motion is not stopped if an EOT marker is detected during reverse tape motion.

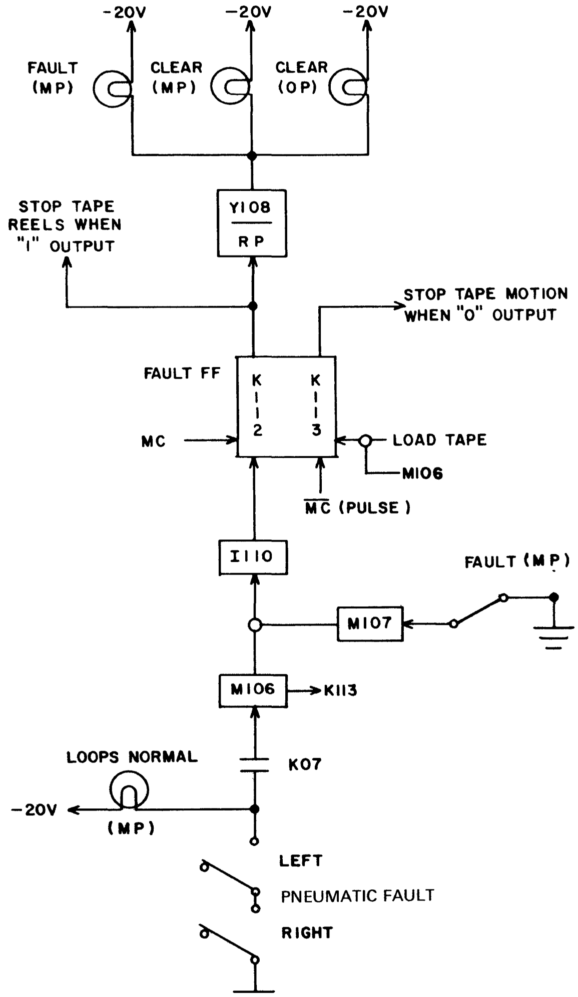


Figure 2-5-11. Fault Circuit

Fault

The fault circuit (Figure 2-5-11) stops operation when any one of a number of fault conditions is detected. The presence of a fault condition disables the AND input to I110 which sets the Fault FF (K112/113).

The Fault FF is set if:

1. The Pneumatic switches are open (indicating that tape has been removed from the vacuum column). The Loops Normal Light on the maintenance panel is turned off when the switch is opened.

2. Fault switch on maintenance panel is pressed (open).

3. Relay K03 is de-energized (capstan and pump motors off). Relay K07, in parallel with K03, is also de-energized.

4. There is an external or local master clear. The Fault FF is cleared by a pulse when the master clear is removed.

The Fault FF, when set, initiates the following actions:

1. Lights the Fault and Clear lights on the maintenance panel and the Clear light on the operator's panel
2. Stops tape motion by clearing the Motion FF's.
3. Stops reel servo drive and energizes reel servo brakes.

Note that the Fault FF is cleared when a load tape operation is initiated. Therefore, it is not necessary to remove the fault indication by master clearing the unit before pressing the Load Switch.

Load Point

The sense load point circuit (Figure 2-5-12) detects the load point reflective marker and stops tape motion when the marker is positioned over the photocell.

The sequence of events executed during a sense load point operation is schematically represented in Figure 2-5-13. The following points concerning the operation of the circuit should be noted:

1. Forward selected - tape is moved forward at 150 ips and is immediately stopped when the load point marker is detected by the photocell.
2. Reverse selected - tape is moved in reverse at 150 ips and is immediately stopped when the load point marker is detected by the photocell.
3. Rewind selected - tape is moved in reverse at high speed until the load point marker is sensed. When sensed, the Sense Load Point FF is set and tape motion stops. Because of the high speed of the tape however, the load point marker may be positioned beyond rather than over the photocell. The Sense Load Point FF is therefore cleared; and because in a rewind condition the Search Load Point FF is set, a forward motion is initiated to move the tape back on load point. Tape is then moved forward at 150 ips and immediately stopped when the load point marker is detected by the photocell.
4. If a fault occurs during any operation, I124 produces a "1" output which immediately stops tape motion by clearing the Motion FF's.
5. The pressure pad must be extended before a load point signal can be sent to the TCU. Therefore, during any rewind operation, the TCU is not notified the first time the load point marker is detected (tape moving at high speed), but must instead wait until the pad is extended and the tape unit is actually ready to read or write again.
6. The Sense Load Point FF is cleared only when the load point marker is moved off the photocell and after a delay of 10 ms has elapsed.

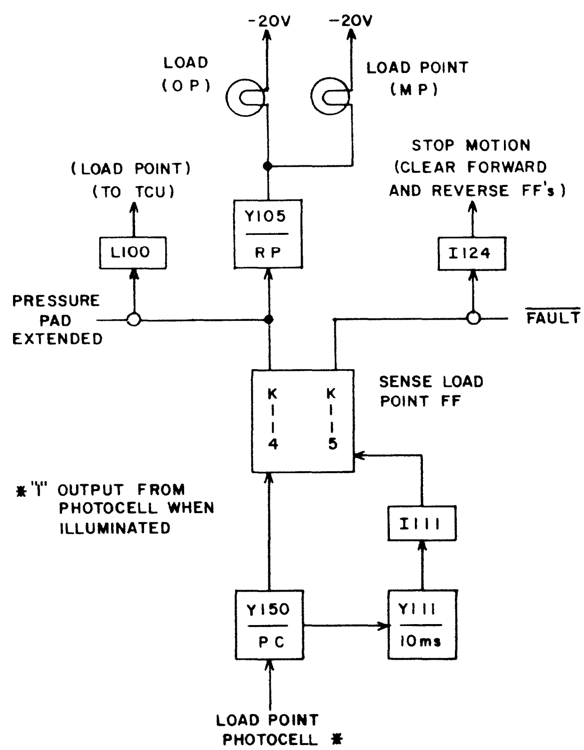


Figure 2-5-12. Sense Load Point Circuit

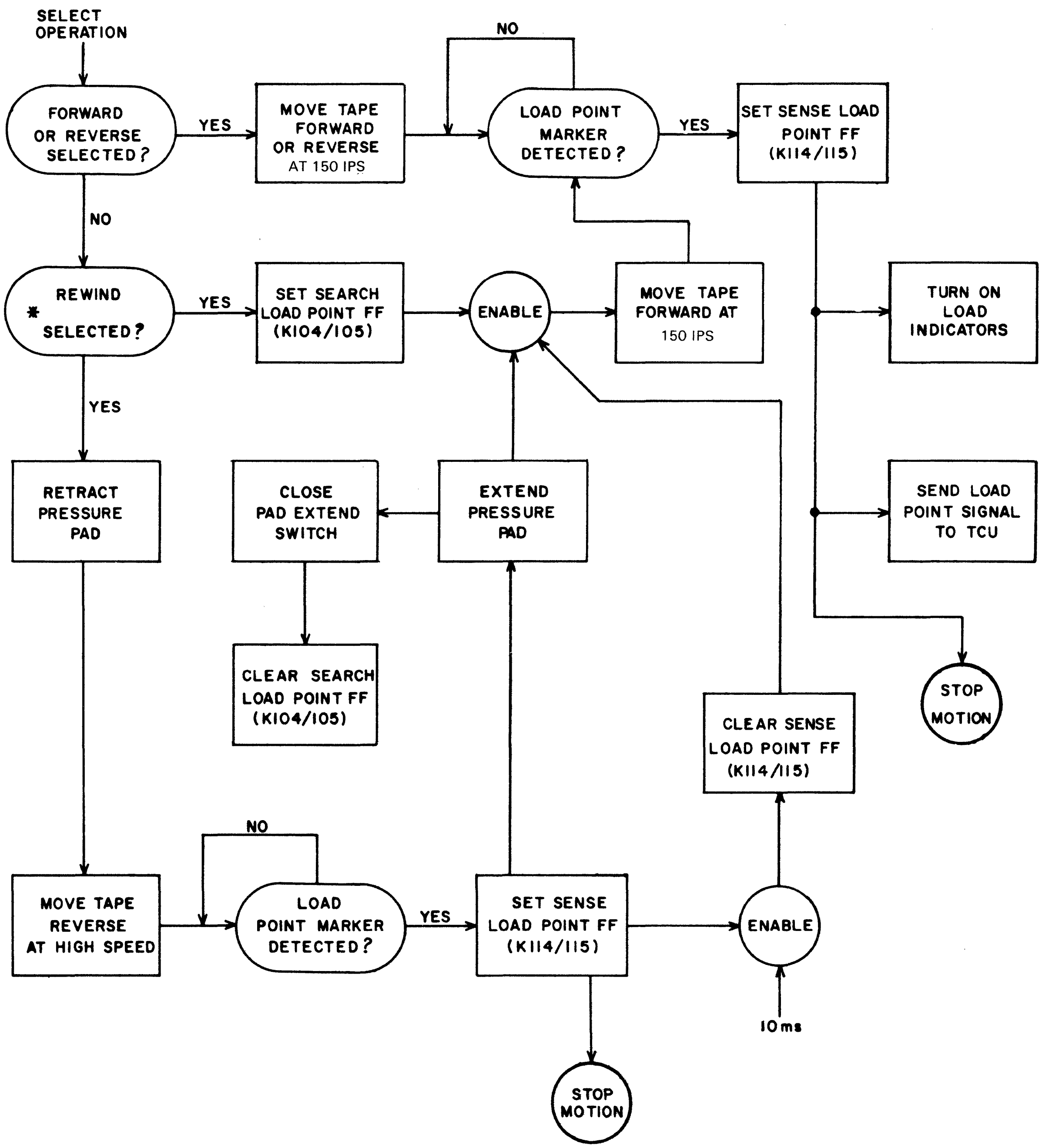


Figure 2-5-12. Sense Load Point Sequence

PAD EXTEND CIRCUIT

The pad extend circuit (Figure 2-5-14) extends the pressure pad prior to low speed (150 ipts) operation and retracts the pressure pad prior to high speed operation. The tape cleaners are turned on when the pad is extended and turned off when retracted. The pad extend circuit also senses the state of the pressure pad.

The Pad Extend FF (K116/117) is cleared when:

1. Rewind operation is selected, or

2. Tape is in uload status.

The Pad Extend FF, when cleared, allows:

1. -20V output from extend pad relay puller (Y130) to be applied to L104 (pad valve) on the valve panel. This valve then removes pressure from the pad and the pad is retracted.

2. Ground output from tape cleaner relay puller (Y131) which, when applied to L103 on the valve panel, removes vacuum from cleaning ports.

When the pressure pad is retracted, the pad switch is opened resulting in a 50-us pulse from I105. This pulse indicates that the pad is retracted and a high speed operation may be performed.

Note that while the Pad Extend FF is cleared, the output from I101 is a "0". This indicates that the pad is no longer extended.

The Pad Extend FF is set by:

1. Local or external master clear, or

2. Tape at load point.

The Pad Extend FF, when set, allows:

1. Ground from Y130 and pad is extended when pressure is applied by L104.

2. -20v output from Y131 and vacuum is applied to cleaning ports.

While the pressure pad is in the process of extending, the pad switch is closed. After a delay of 404 ms, the output from I101 changes from "0" to "1". This indicates that the pressure pad is fully extended and a read or write operation may be performed.

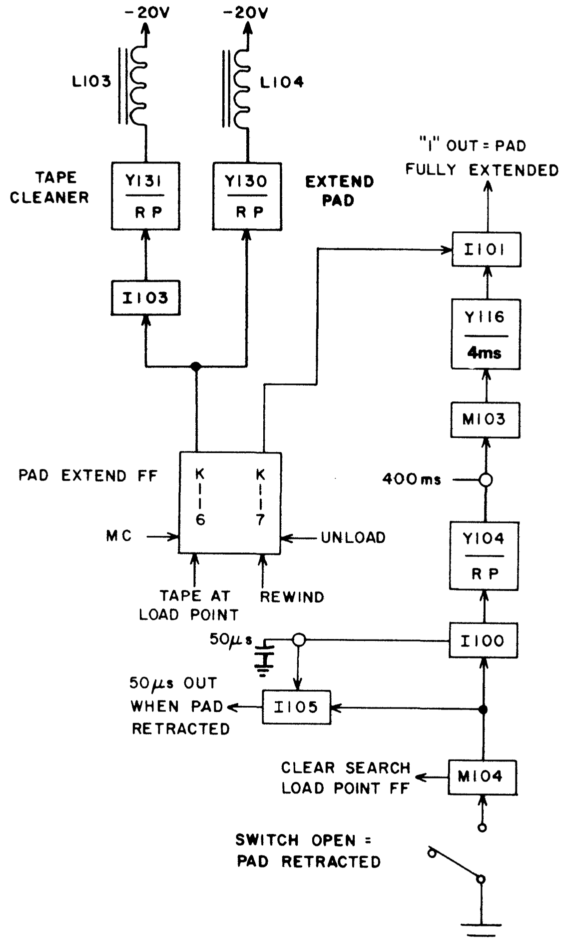


Figure 2-5-14. Pad Extend Circuit

LOAD TAPE

The load tape circuit allows tape to be moved from an unload status (all tape on supply reel) to the tape loaded status (tape at load point). The sequence is described by figure 2-5-15.

REWIND

The rewind circuit allows tape to be rewound from the take-up reel to the supply reel at a rate of over 320 ips. Motion stops when a load point marker is sensed. The sequence of events necessary to execute a rewind operation is described by figure 2-5-20.

REWIND UNLOAD

The rewind unload circuit reverses tape at high speed from take-up reel to supply reel. Tape motion stops at load point, then continues at 150 ips until a fault occurs. Figure 2-5-23 details the rewind unload sequence.

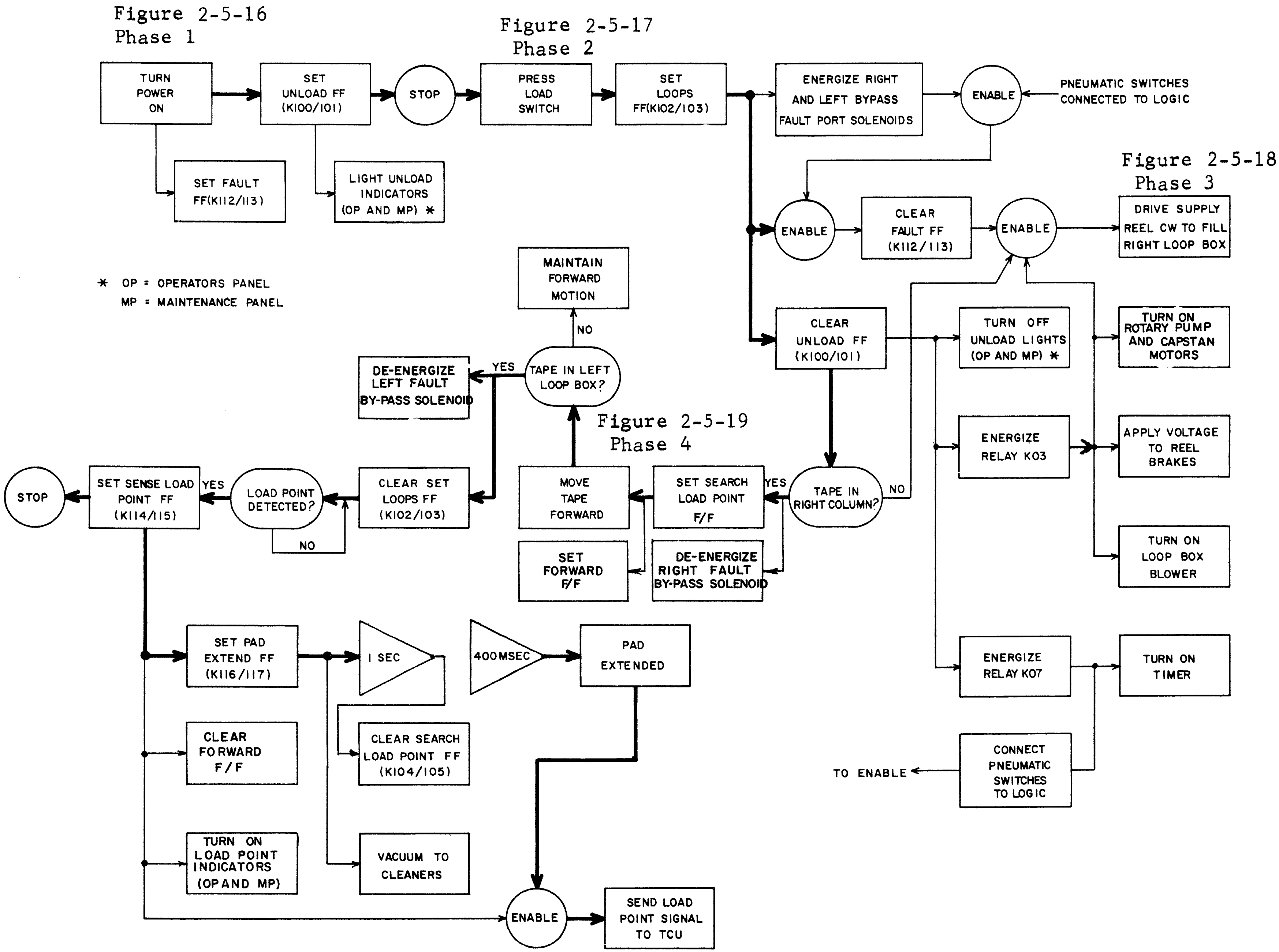


Figure 2-5-15. Load Tape Operation

Machine is shown in "Unload" Condition. Vacuum Pumps Off, Fault Bypass Solenoid Valves De-energized, and S111 and S112 are open. Atmospheric pressure is applied to both sides of the Pressure Differential Switches.

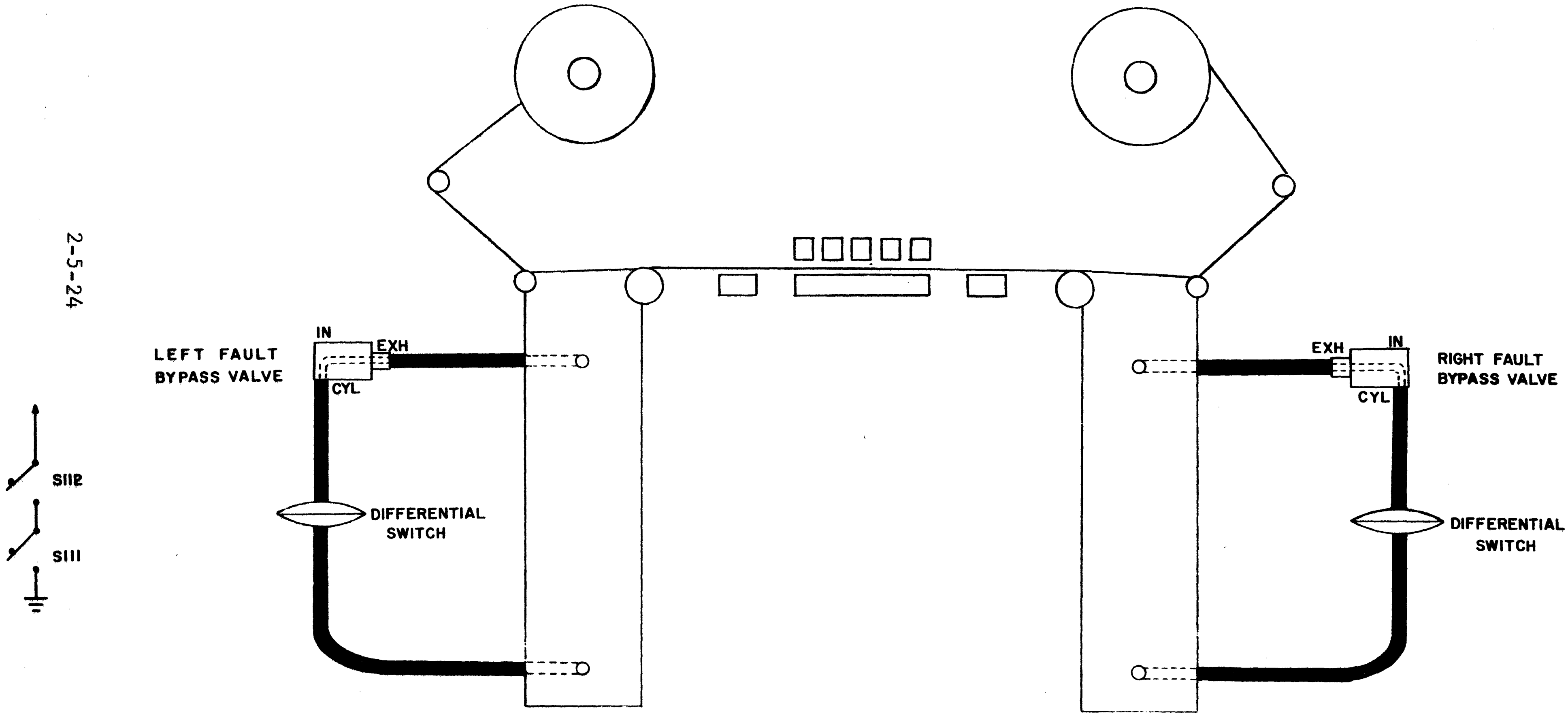


Figure 2-5-16. Fault Circuit - Phase I

Phase 2 illustrates conditions occuring after "Load" switch has been depressed. Loop Box Vacuum is present, Right and Left fault bypass soledoid valves are energized, Atmospheric pressure is gated through the valves to the top of the differential switches and vacuum is gated to the bottom of the Differential switches. The resultant pressure differential cause S111 and S112 to close. This will now remove the "Fault" condition.

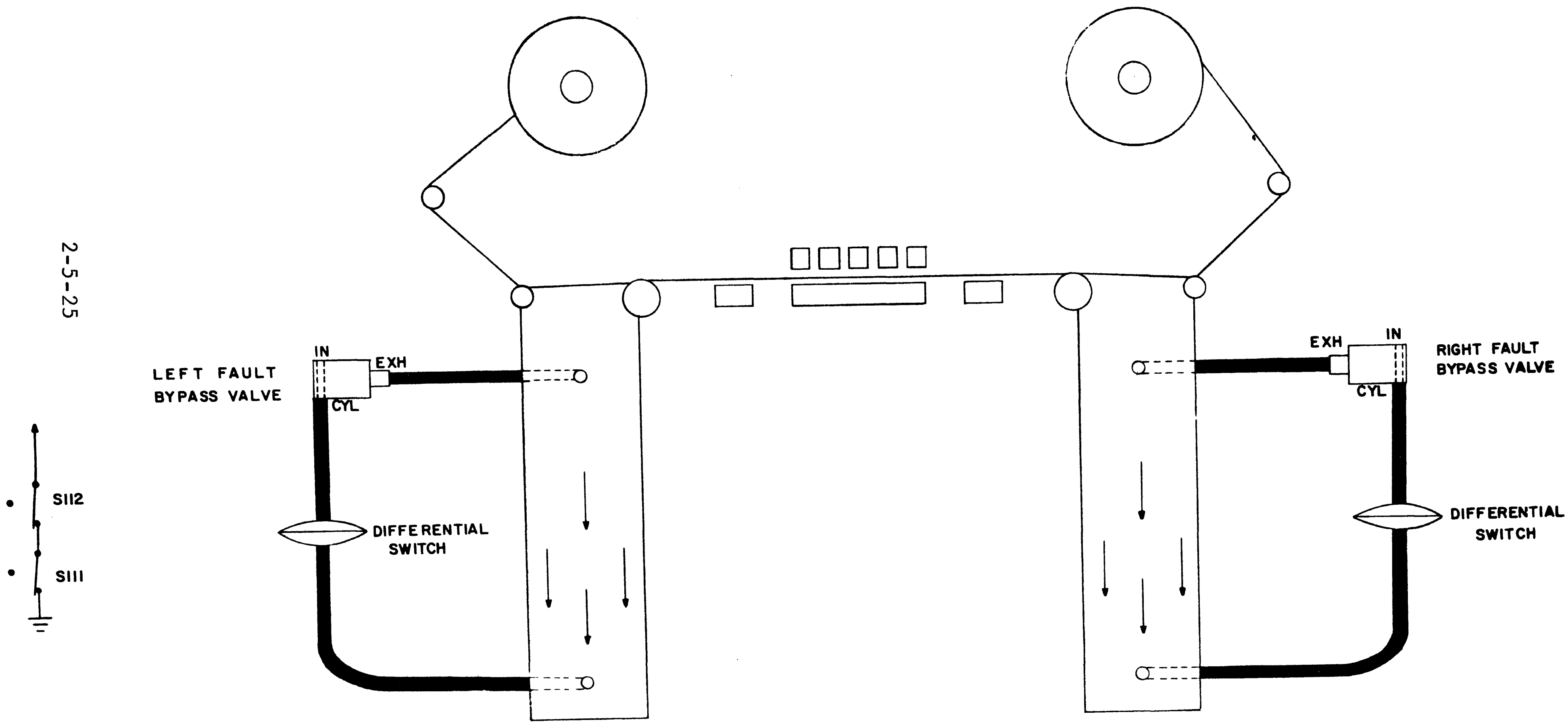


Figure 2-5-17. Fault Circuit - Phase 2

When Phase 2 is complete, the Servo Drive System will cause the Supply Reel to rotate clockwise, putting tape into the right column. As the tape covers the top right photocell, the Right Fault Bypass Solenoid Valve will de-energize. The top fault port is sensing Atmospheric pressure and the bottom fault port is sensing vacuum. The Take-up reel is disabled at this time since the Servo Drive Circuitry is trying to cause counterclockwise motion of the reel.

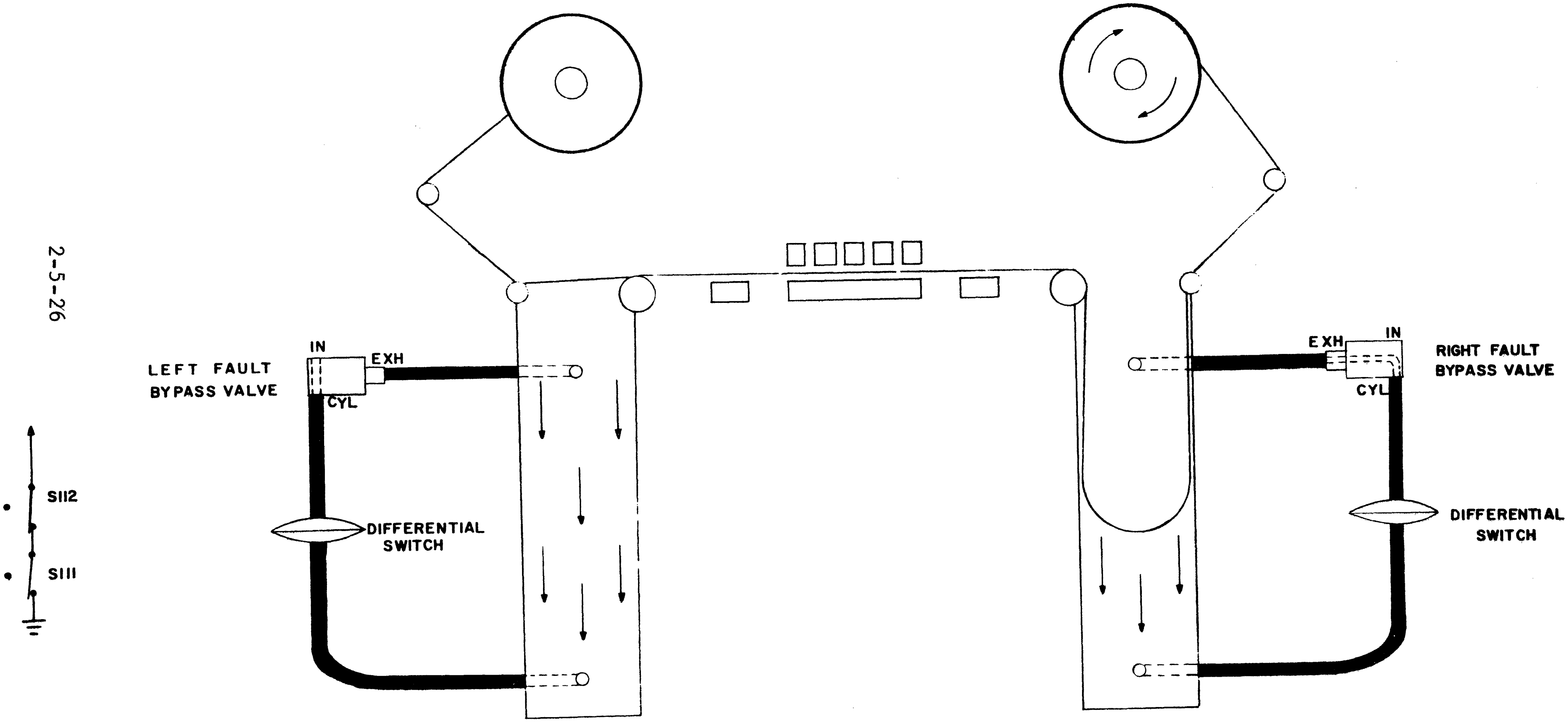


Figure 2-5-18. Fault Circuit - Phase 3

Phase 4 shows Vacuum being applied to the Forward Capstan. This will place tape in the left column. As the tape covers the top left photocell, the left fault bypass solenoid valve will de-energize. Tape will now move forward until load point is detected. The Servo Drive Control will control the amount of tape in the column.

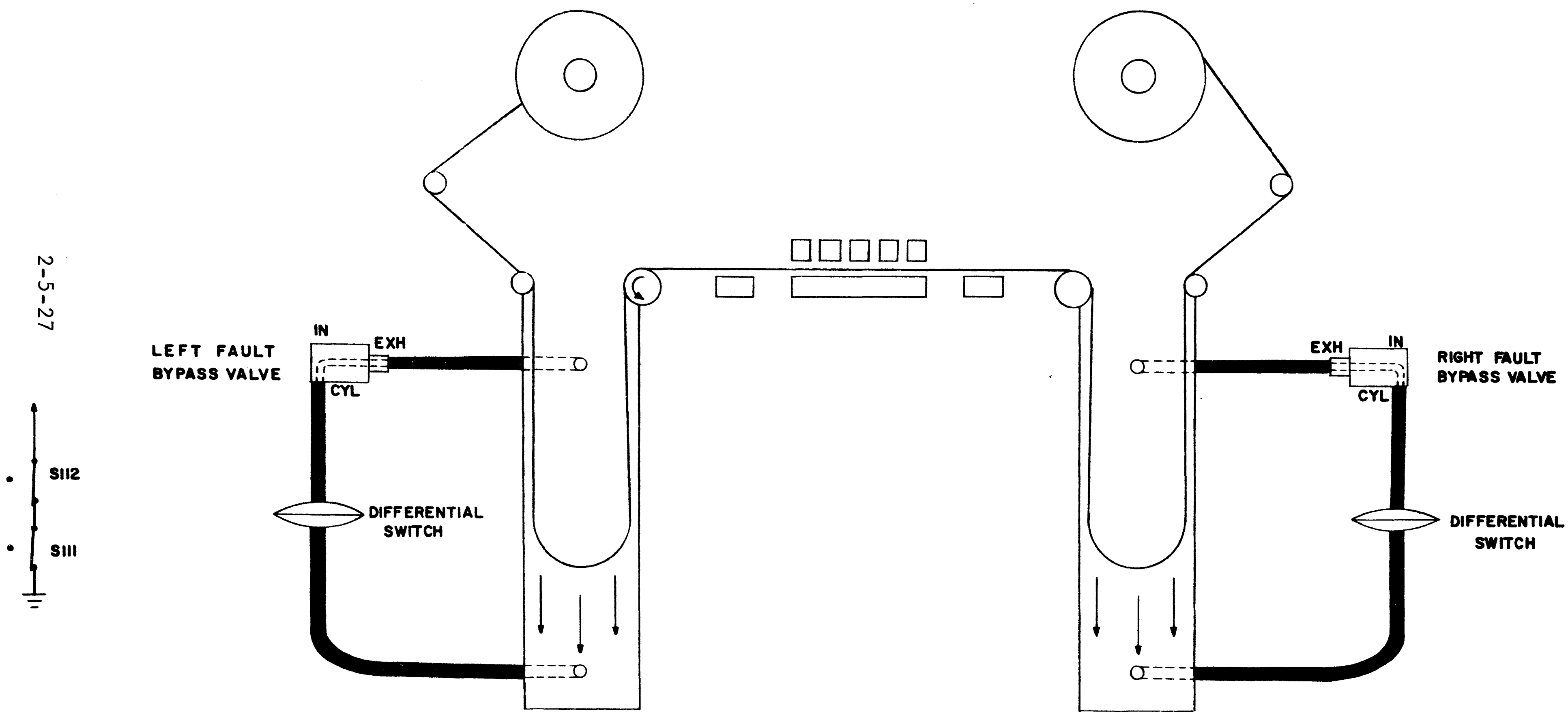


Figure 2-5-19. Fault Circuit - Phase 4

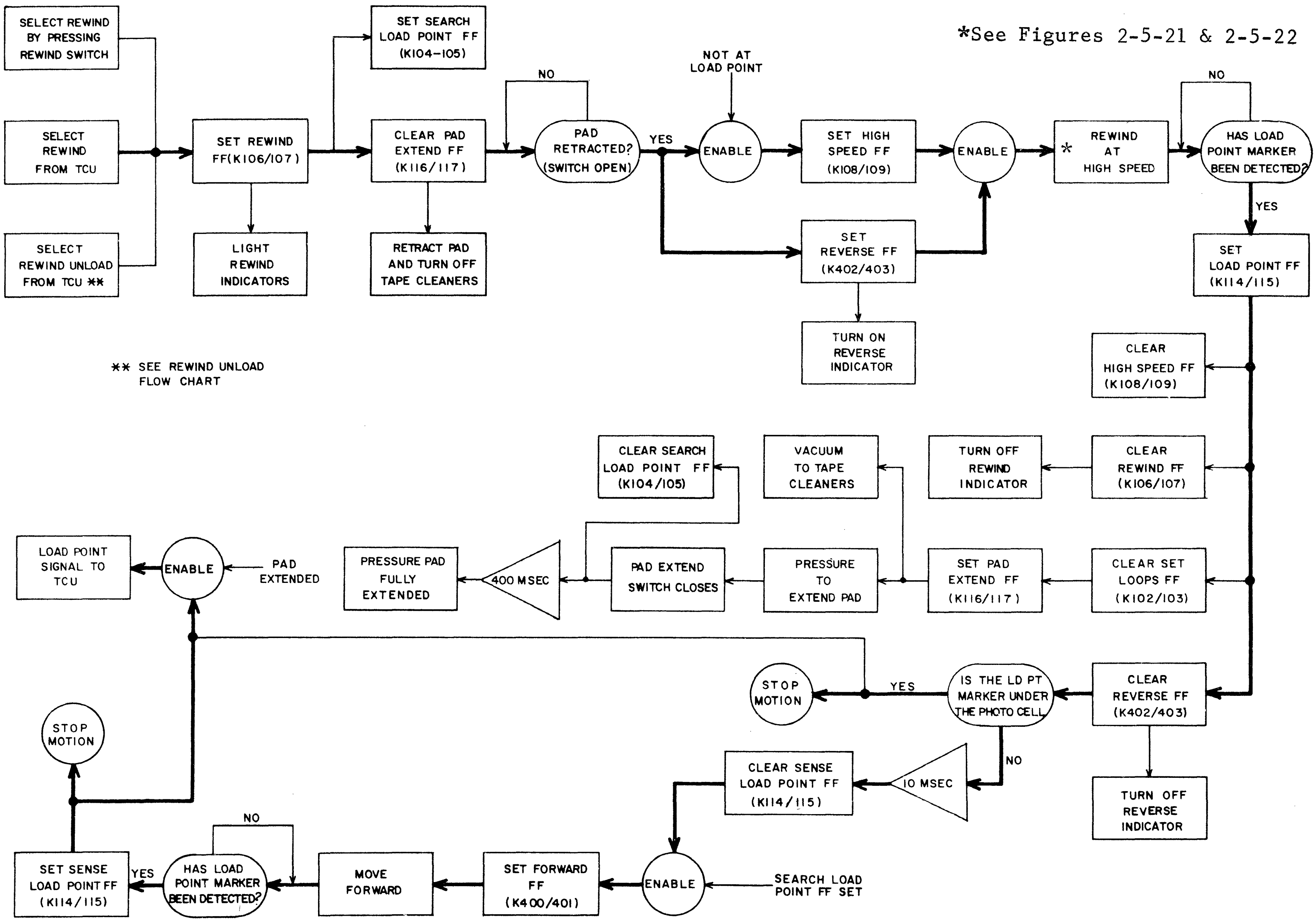


Figure 2-5-20. Rewind Operation

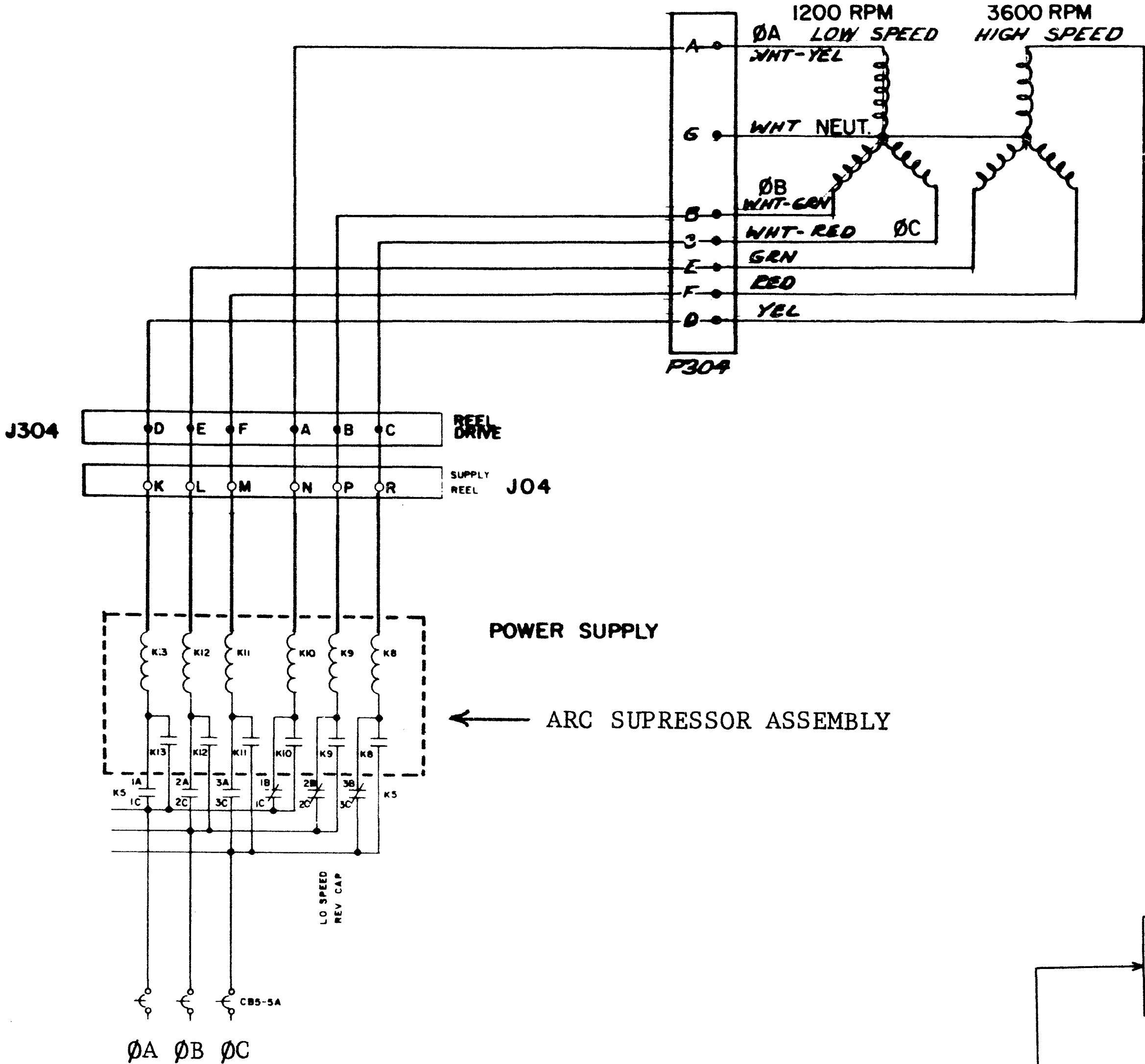
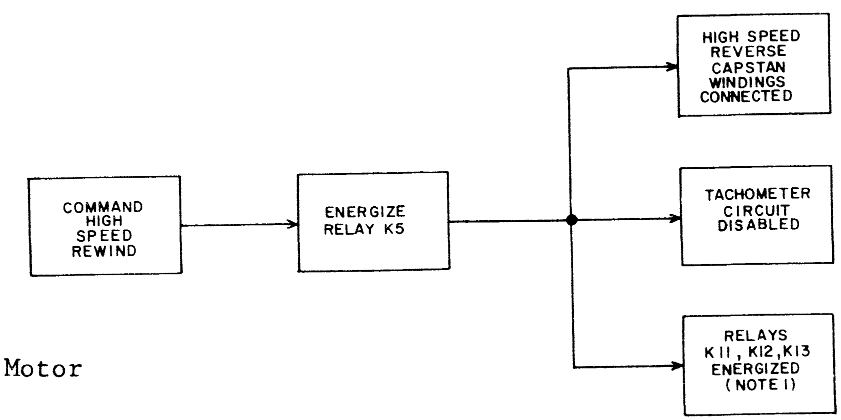


Figure 2-5-21. Reverse Capstan Motor Schematic



NOTE:
1. RELAYS K11, K12 AND K13 REDUCE K5 CONTACT ARCING AND NOISE WHEN HIGH SPEED REVERSE CAPSTAN CONTACTS ARE OPENED.

High Speed Rewind Sequence in Power Supply

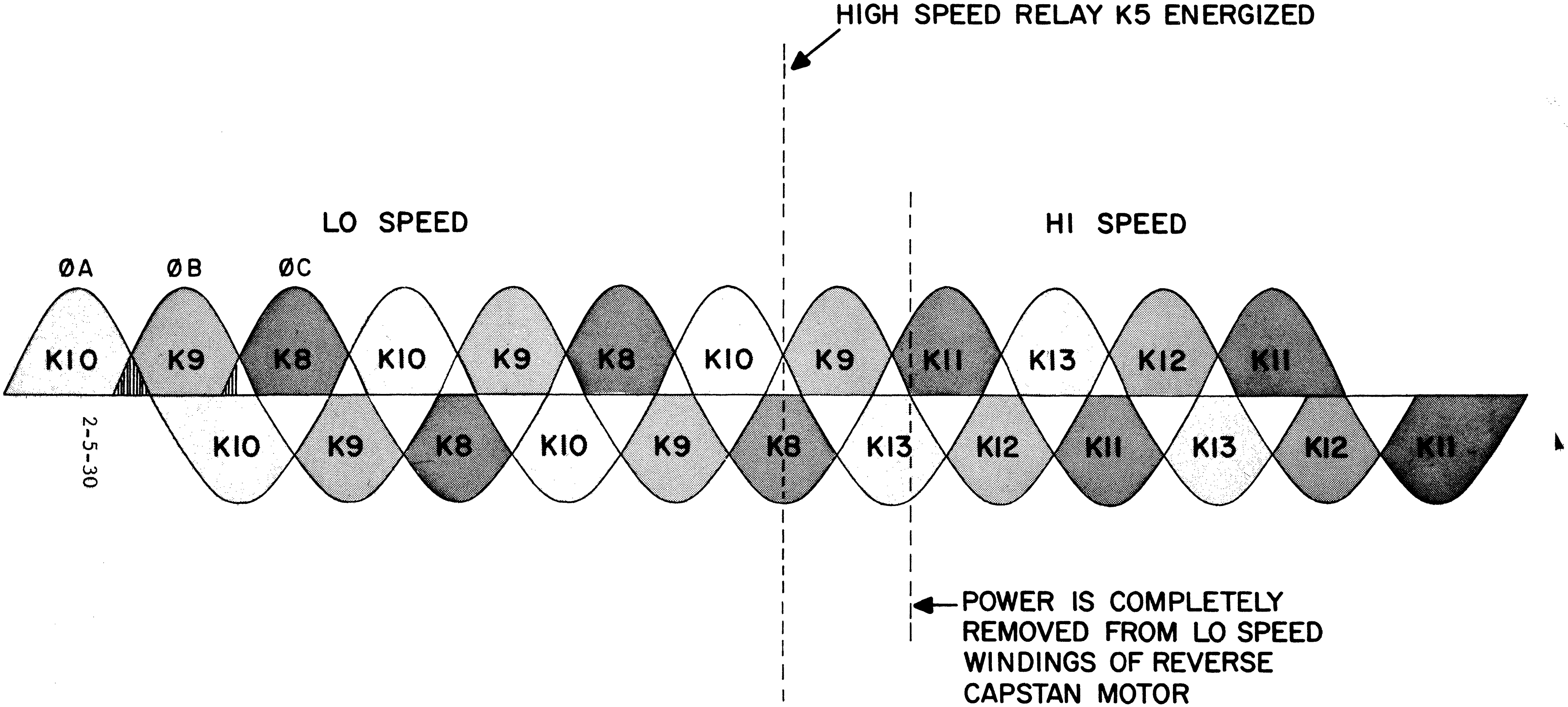


Figure 2-5-22. ARC Supressor Assembly

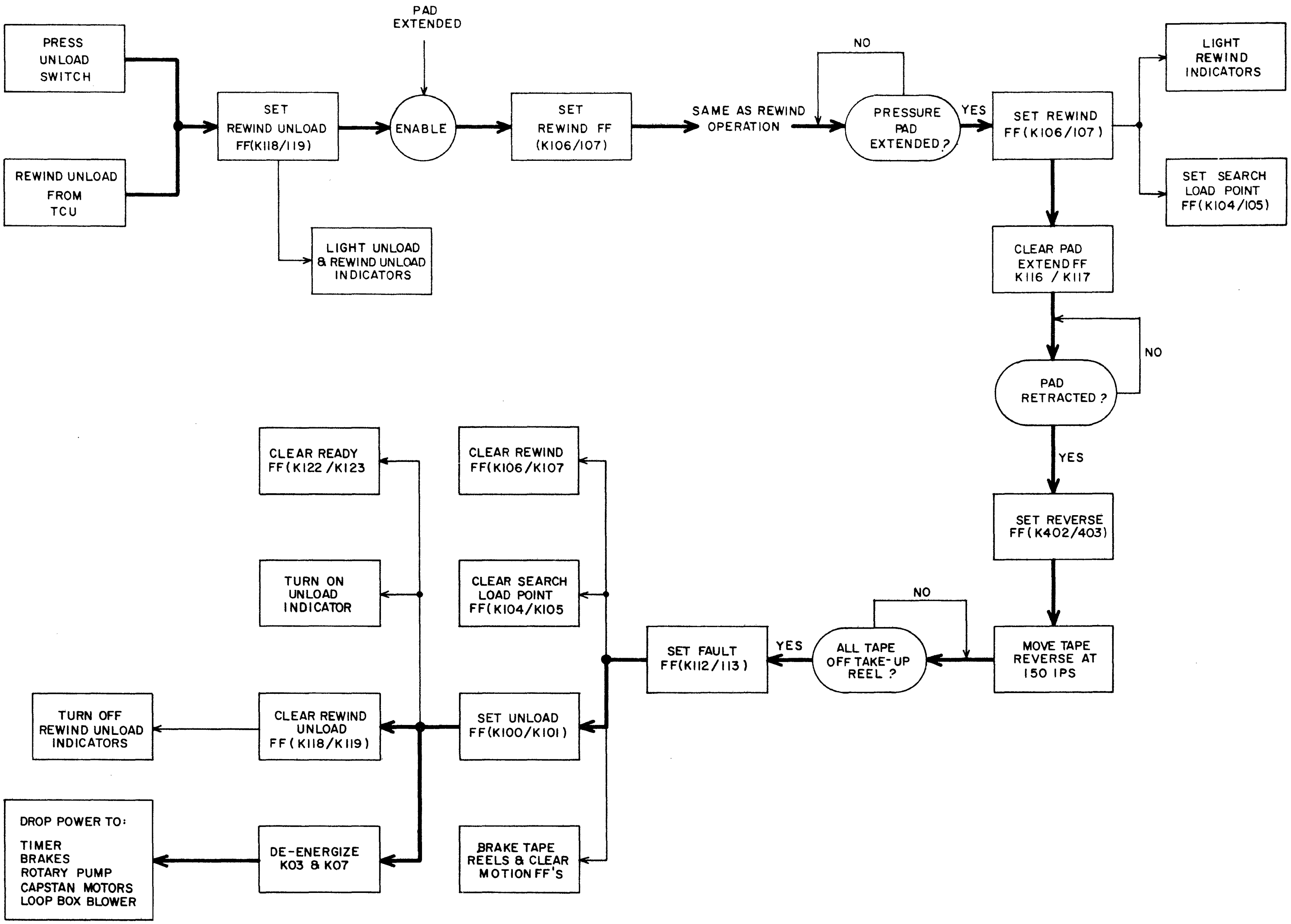


Figure 2-5-23. Rewind Unload Operation

WRITE CONTROL

The write control portion of the tape unit logic consists of write data circuits and an associated write enable circuit (Page 2-77). The write data circuits accept information in the form of 7-bit characters from the TCU and route the data to the write heads for recording. The enable circuit allows the information to be transferred from the TCU to the write heads if a write operation is selected.

WRITE ENABLE CIRCUIT

A write operation is selected only by a write select signal from the TCU. This signal must remain up during the entire write operation. However, before the actual write operation is performed, a number of enable conditions specified by the AND inputs to Y000 and K070 must first be satisfied.

Y000 receives a "1" (enable) input only if tape is not in the Unload condition and the file reel (supply reel) contains a file protection ring (file protect switch closed).

FILE PROTECTION RINGS

The back of the file reel has a slot near the hub which accepts a plastic file protection ring (Figure 2-5-24). Writing on a tape is possible only when the reel contains the file protection ring. The tape may be read with or without the ring. Presence of a ring on a reel of tape is signaled by the overhead lights which turn on immediately after the tape load procedure is executed. The lights remain on until the tape unit is placed in the unload status and the ring removed from the file reel after writing is completed, to avoid loss of valuable records through accidental re-writing.

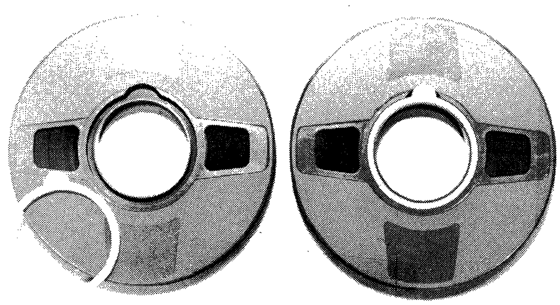


Figure 2-5-24. File Protection Ring

The file protect switch will be in the outer stop position (condition 1) if a reel has the file protect ring missing. This will prevent any writing on the tape. Position 2 of the switch will be present if a file protect ring is on the reel. Once a load tape operation is initiated, the switch arm will pull back to the inner stop position (3). This is to prevent the switch from forming a groove in the file protect ring as the reel turns.

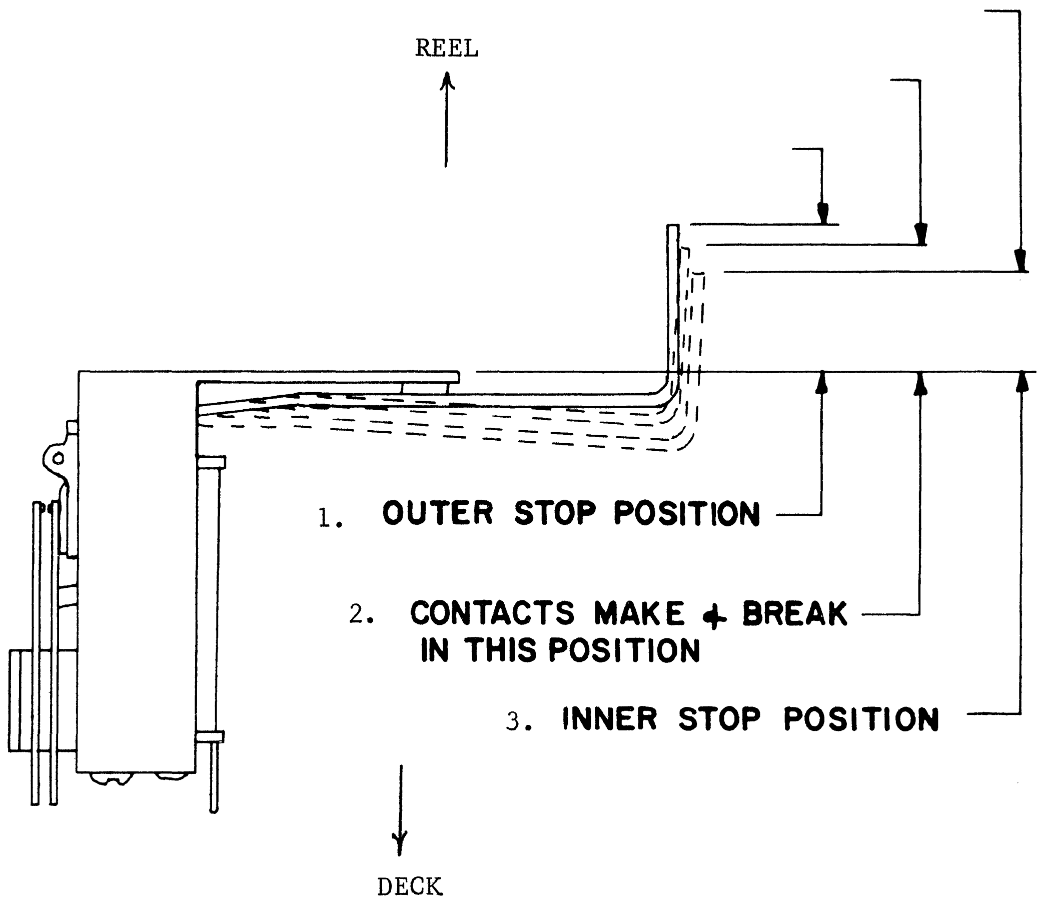


Figure 2-5-25. Reel Sensor Assembly (File Protect SW)

When the file protect switch is closed, the resulting ground output from Y000:

1. Returns a write ready signal to the TCU indicating that the reel contains a file protection ring and is loaded.

2. Holds the File Protect switch closed by means of the Write Enable solenoid K104.

3. Selects the Write Enable relay K103 which turns on the overhead lights. These lights are turned on only when the file protection ring is detected.

The Write FF (K070/071) is set only when all of the conditions comprising the AND input are present. If all the conditions exist, Y000 receives a "1" input and turns on the Write indicators on the operator's and maintenance panel. The "1" input to Y002 allows current to flow through the erase head.

Before a write operation is selected and enabled, the Write register is initially stabilized in the clear state due to the "1" output from I008 and I016. These outputs clear the Write register, permitting write current to flow in the same direction as they are when tape is erased. This procedure, therefore, eliminates the possibility of "1" bits being recorded on the tape when a write operation is first selected.

If a write operation is not selected or enable, I014 produces "1" output that clears the Write FF. The Write register is held in the clear state. Note that during non-write operations, Y001 receives a "1" input from K070 which allows dummy load current to flow through external load resistors. The power supply load is therefore approximately constant under non-writing conditions.

The write data circuits accept information from the TCU in the form of 7-bit characters and route the data via the Write register to the write heads for recording.

A sprocket signal indicates that a 7-bit character is on the input line and may be sampled and routed to the Write register. The presence of a write sprocket signal results in a "1" input to the pulse delay cards. The delay cards are individually adjustable to that each bit can be gated into the register at the time necessary to vertically align all bits on the tape.

The individual Write Register FF changes state each time a "1" is to be written on that particular track: the FF remains unchanged if a "0" is to be recorded. The TCU, in other words, must supply NRZ1 input data to the tape transport.

The generation of NRZ1 information is done in the tape controller. Whatever state W_1 in the controller is in (Figure 2-5-6) will be transmitted to the associated write drives in the 606. The state of W_1 will change only when a "1" is to be recorded.

Initially W_1 and W_2 are cleared. When Bit 0 is gated by the "B-W_1" will change only when a "1" is to be recorded.

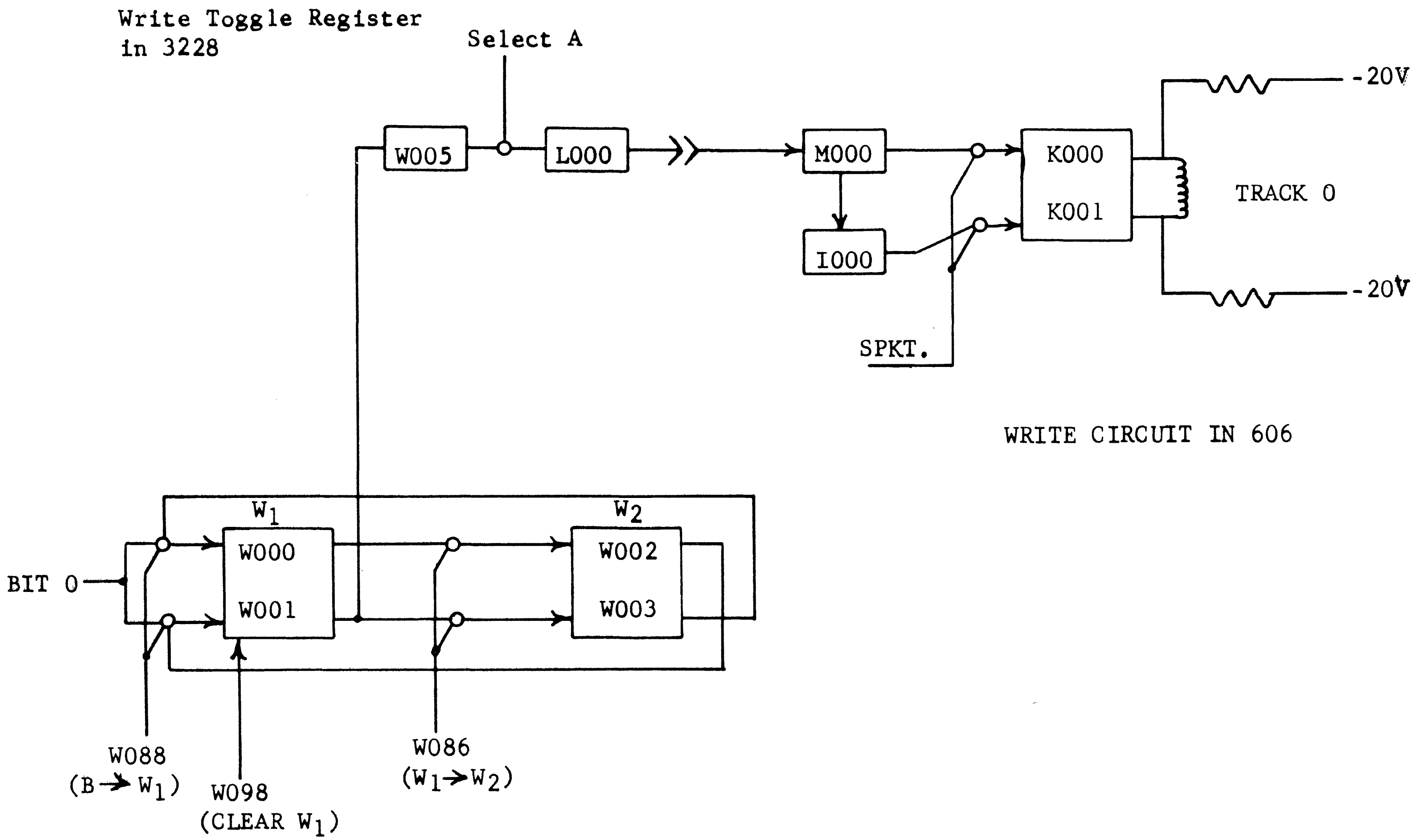


Figure 2-5-26. Generation of NRZ1

BCD Code
T = 23
I = 71
M = 44
E = 65

	T	I	M	E
Bit 6	1	0	0	0
5	0	1	1	1
4	1	1	0	1
3	0	1	0	0
2	0	0	1	1
1	1	0	0	0
0	1	1	0	1
	1st	2nd	3rd	4th

The word "time" broken down into 4 frames. BCD codes are used.

State or condition of W_1 register for each frame. S=set, C=clear for state of flip-flops. $\underline{S}$ = flip flop had been previously cleared and is not set. This underlined term indicates a change in state which means a change in current through the write head. Therefore, a "1" bit would have been recorded.

	1st	2nd	3rd	4th	Clear W_1 (Write Check Character)	
Bit 6	$\underline{S}$	S	S	S	$\underline{C}$	1
5	C	$\underline{S}$	$\underline{C}$	$\underline{S}$	$\underline{C}$	1
4	$\underline{S}$	$\underline{C}$	C	$\underline{S}$	$\underline{C}$	1
3	C	$\underline{S}$	S	S	$\underline{C}$	1
2	$\underline{C}$	C	$\underline{S}$	$\underline{C}$	C	0
1	$\underline{S}$	S	S	S	$\underline{C}$	1
0	$\underline{S}$	$\underline{C}$	C	$\underline{S}$	$\underline{C}$	1

173 would be the check character. It is a result of the clear W_1 pulse. This is used only for longitudinal parity and must not be confused with data.

Figure 2-5-27. Writing the Word "Time" on Tape

Figure 2-5-27 illustrates what happens to the toggle register when a word is to be written.

READ CONTROL LOGIC

The seven read data circuits detect, convert, and route information from the tape to the external equipment.

During a read operation, tape data are detected by the read heads, amplified by preamplifier cards, and rectified and detected by level and peak detectors. The information bits are then placed in rank I of the 7-bit Read register. The lower order six tracks of the register receive the information character; the highest order track receives the parity bit. After the information is placed in rank I, the bits are delayed to compensate for electrical and mechanical skewing. The information bits are next gated from rank I to rank II by a pulse from the read gate control circuit. Rank II provides short-term storage for the information bits, while the bits are placed on the output lines for transfer to the TCU.

Information data outputs are also taken from the rank I and rank II read registers to provide an indication of information storage, register status, and type of information flow to the control circuits.

LEVEL SHIFT NETWORK

Only the partially summed negative bits are supplied to the level shift network from the read preamplifier. The level shift network is basically an emitter follower with a variable output level attenuator. The reduced bit level output is supplied to the read level detector where the level shift network output is compared with the information bits. If the pulse level is above a predetermined level, the pulse is coupled--if not, the pulse is blocked.

READ GATE

The read gate circuit controls the coupling of information through the read data circuit to the output lines. The information in read register I is delayed by the skew delays of the read gate circuit, to compensate for physical displacement of the head tracks and for differences in preamplifier, level and peak detector circuits. Information in rank I is gated to rank II after a delay has elapsed. The delay is determined by the read density selected or by a write condition. Information in rank II is coupled to the TCU.

Initial information comes from rank I which:

1. Partially enables the AND gate and allows information to transfer from rank I to rank II. If the 556-bpi density is selected, a delay of 2 usec must be exhausted. If the 200-bpi density is selected, and additional delay of 9 usec is required.

2. Partially enables the AND gate to clear rank I. This gate is fully enabled 0.5 usec after the Read register information is gated to rank II.

3. Clears the End of Record FF to assure that an end of record has not been reached.

Simultaneous with the first information sample, a second output sample of the rank I Read register is supplied to the skew delay circuits. The information outputs of the skew delay circuits are then supplied to density delay circuits which delay the information transfer to rank II for a time determined by the density selected. This allows sufficient time for all bits to be detected by rank I. Consequently, all information is stored in rank I before the information is gated in rank II.

With the information in rank II, a third sample is supplied to read gate circuit I544. This sample enables the AND input to I506, to clear read register rank I (after 0.5 usec). Rank II is cleared 2 usec after K584/585 is set. The read process is then repeated.

If neither a read nor a write operation is selected, the "1" output from Y543 results in a continuous "1" output from I508 and I511. Rank I of the read register is held in the clear state and a read operation is disabled. When a read or write operation is initially selected, I508 and I511 continues to produce a "1" output for 2 msec because of the Y543 delay. This precaution eliminates the possibility of transient noises being read as information while tape is brought up to speed.

SELECT READ

The select read circuit enables the read circuit and the motion operations either by local selection or by programmed select read. This circuit also provides an indication of the read operation.

A read select signal from the TCU or from the maintenance panel read switch sets the Select Read FF, enabling the read circuit and causing the read indicators to illuminate.

The Select Read FF is cleared when forward or reverse tape motion is terminated or when an end of operation signal is produced by the file mark stop circuit. Consequently, the read operation must be reselected to initiate read.

A forward or reverse motion operation cannot be initiated by the TCU until a read or write operation is selected. Also a rewind or rewind unload operation cannot be initiated until a previously selected rewind or unload operation is completed.

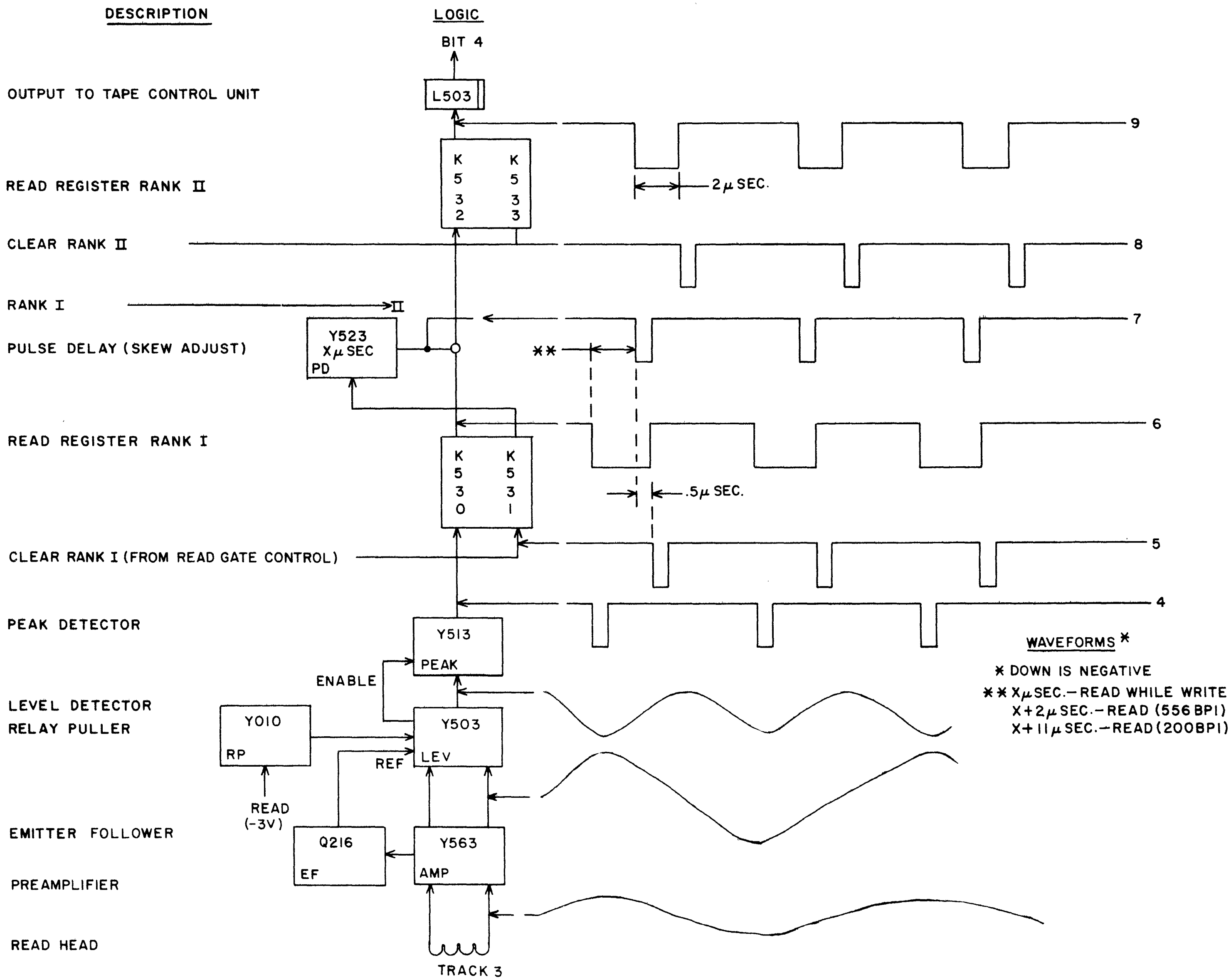


Figure 2-5-28. Typical Read Data Circuit

SELECT DENSITY

The tape transport select density circuit provides control to the circuits and an indication of density selected. This select circuit can be manually controlled from the operator panel or indirectly controlled by the central processor.

The manually selected high density supplies a "1" from the input circuit to the Set Select Density FF. The FF output is supplied to the high density relay puller causing the respective indicator to illuminate; to the read gate circuit to enable the appropriate delay, and through an output circuit to the central processor as an electrical indication of tape density.

FILE MARK STOP AND END OF RECORD

The file mark stop circuit provides an end of operation pulse to the TCU and stops motion during read if an end of record, load point marker, or file mark is detected when a stop on file mark has not been selected. If a stop on file mark is selected, motion stops only when a file mark or load point marker is detected.

Stop on file mark is a circuit condition that is externally controlled from the TCU. Once the stop on file mark is selected, the tape input must have a double octal 17, followed by an end of record space, to produce an end of operation and file mark output.

The Stop on File Mark FF is set 1 usec after a "1" is applied from the TCU. The output of the Stop on File Mark FF prevents an end of operation signal to the TCU.

When the space (end of record) after the double octal 17 is reached, the End of Record FF is set. The "0" output initiates the 200 usec delay timer.

The "0" output of the 200 usec delay circuit is applied through an inverter to partially enable the end of operation AND output, to a 10 usec delay circuit, and to partially enable the AND input to the Stop on File Mark FF.

The octal 17 input from read register rank II, AND's the input to I529 producing a "0" output with no effect. Simultaneously, the octal AND's the input to the File Mark FF. After a 1 usec delay the File Mark FF is set causing a "1" output. The "1" output is supplied to the AND input of the Stop of File Mark FF which allows the flip-flop to clear. The "1" output also partially enables L508. This enables the end of operation AND circuit, coupling the end of record pulse to the TCU.

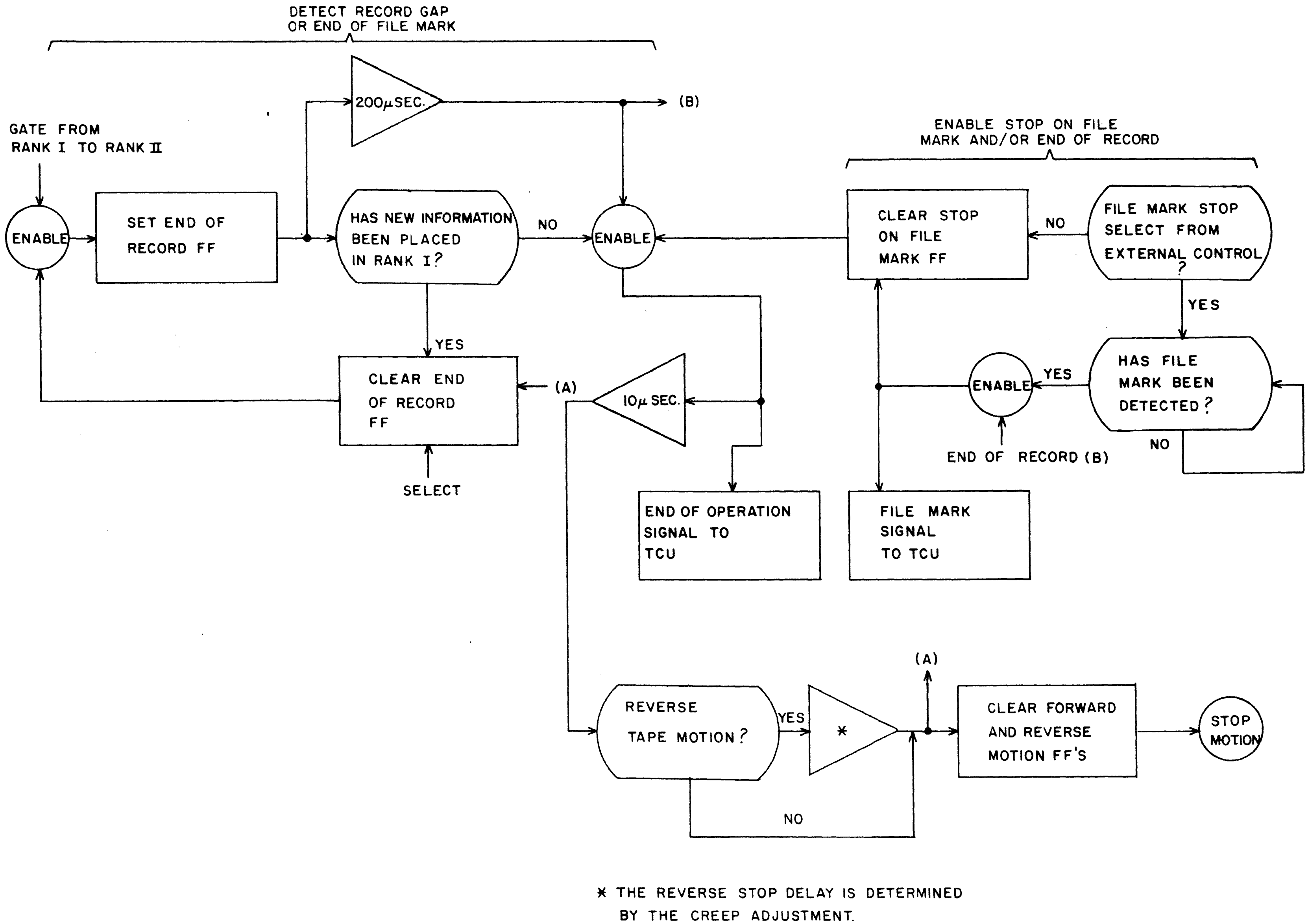


Figure 2-5-29. File Mark Stop and End of Operation Flow Chart

LOAD TAPE OPERATION

1. Power on
   a. Set unload FF
   b. Set fault FF
   c. Clear set loops FF
   d. Clear rewind unload FF
2. Depress load switch on operators panel
   a. Set the set loops FF
   b. Energize fault by pass solenoids
   c. Clear unload FF
   d. Energize rotary pumps, capstan motors and reel drive motors
3. When pressure and vacuum builds up
   a. Drive supply reel clockwise
   b. Loop forms in right hand buffer column
4. Tape loop in right hand column drops below upper photocell
   a. Deenergize right fault bypass solenoid
   b. Set search load point FF
   c. Set forward FF
5. Forward capstan moves tape in forward direction
   a. Loop forms in left hand column
   (CCW motion of take up reel disabled)
6. Tape loop in left hand column drops below upper photocell
   a. Deenergize left fault bypass solenoid
   b. Clear set loops FF

7. Load point is detected

    a. Set load point FF

    b. Clear forward FF

    c. Set extend pad FF

8. Pressure pad extends

    a. Pad switch closes

    b. Clear switch load point FF

    c. Load point signal to synchronizer

REWIND

1. Depress rewind switch on operators panel

   a. Set rewind FF

      1) Set search load point FF

      2) Clear extend pad FF

      3) Partial enable to set reverse FF

2. Pressure pad retracts

   a. Pad switch opens

      1) Set high speed FF

      2) Set reverse FF

3. Move tape in reverse

   a. Gate vacuum to reverse capstan

      1) Left top photocell "off" and right bottom photocell "on"

   b. Gate pressure to reverse capstan

      1) Left top photocell "on"

      2) Right bottom photocell "off"

4. Load point detected

   a. Set load point FF

      1) Clear high speed FF

      2) Clear rewind FF

      3) Clear reverse FF

      4) Set extend pad FF

5. Overshoot load point marker

   a. 10 msec past load point

1) Clear load point FF

2) Set forward FF

6. Tape moves forward (normal speed)

7. Load point detected moving forward

   a. Set load point FF

      1) Clear forward FF

8. Pressure pad extends, switch closes

   a. Clear search load point FF

   b. Send load point signal to synchronizer

REWIND UNLOAD OPERATION

1. Depress unload switch on operators panel

   a. Set rewind unload FF

      1) Set rewind FF

      2) Set search load point FF

      3) Clear extend pad FF

      4) Partial enable to set reverse FF

      5) Clear ready FF

2. Pressure pad retracts

   a. Pad switch opens

      1) Set high speed FF

      2) Set reverse FF

3. Move tape in reverse

   a. Gate vacuum to reverse capstan

      1) Left top photocell "off" and right bottom photocell "on"

   b. Gate pressure to reverse capstan

      1) Left top photocell "on"

      2) Right bottom photocell "off"

4. Load point detected

   a. Set load point FF

      1) Clear high speed FF

      2) Clear rewind FF

      3) Clear reverse FF

      4) Set extend pad FF

5. Overshoot load point marker

   a. 10 msec past load point

      1) Clear load point FF

      2) Set forward FF

6. Tape moves forward (normal speed)

7. Load point detected moving forward

   a. Set load point FF

      1) Clear forward FF

8. Pressure pad extends, switch closes

   a. Clear search load point FF

   b. Set rewind FF

      1) Clear extend pad FF

      2) Partial enable to set reverse FF

9. Pressure pad retracts

   a. Pad switch opens

      1) Set reverse FF

10. Tape moves in reverse. End of tape drops off take up reel

   a. Pneumatic switch opens. Fault conditions

      1) Set fault FF

      2) Apply brakes to drive reels

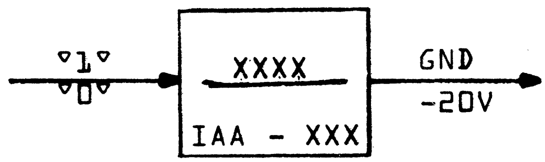
      3) Set unload FF

      4) Clear rewind unload FF

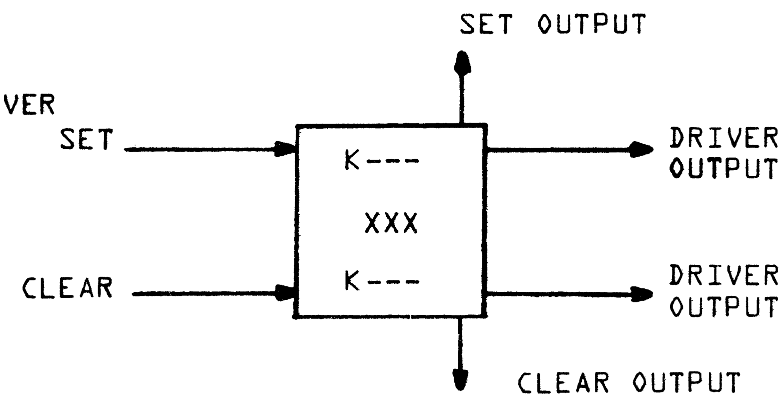
      5) Clear extend pad FF

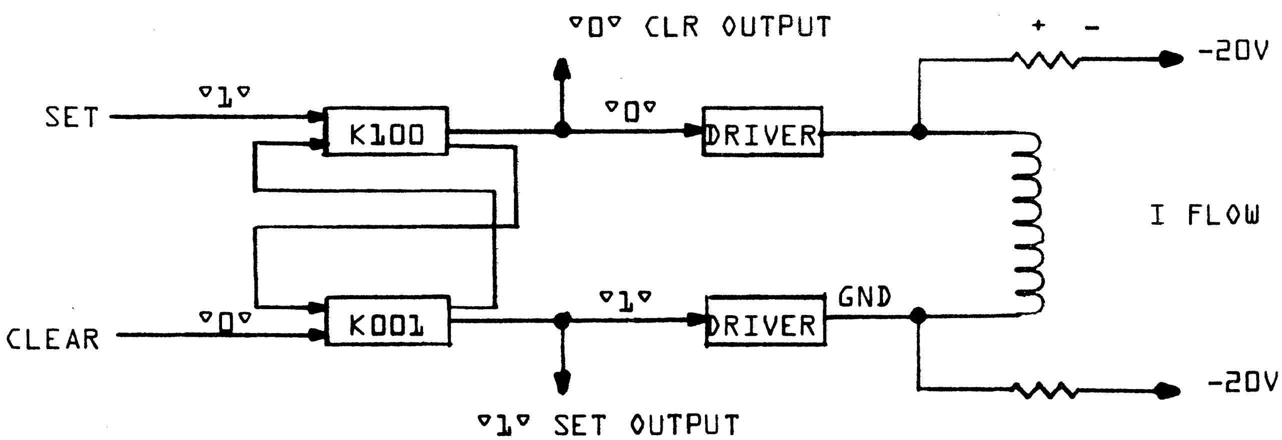
      6) Drop power to pumps, capstan motors and reel motors

1. IAA, IAB - RELAY PULLER

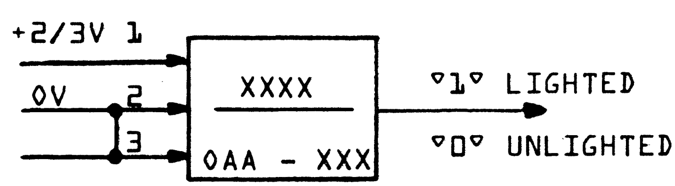


2. IJA - FLIP-FLOP WRITE DRIVER

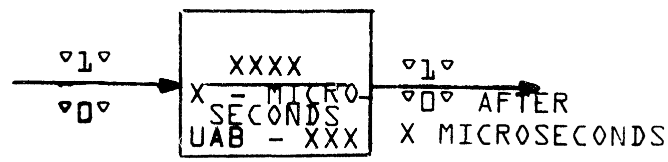




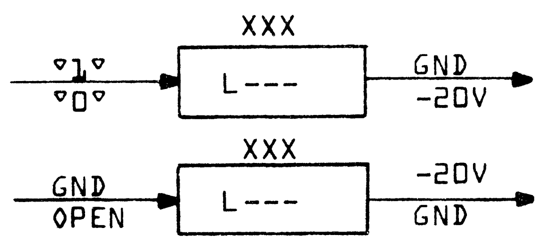
3. OAA - PHOTOCELL AMPLIFIER



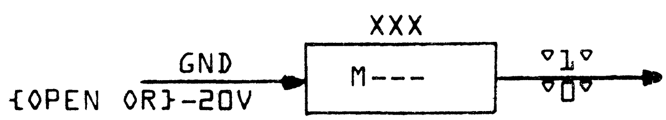
4. UAB - ADJUSTABLE DELAY



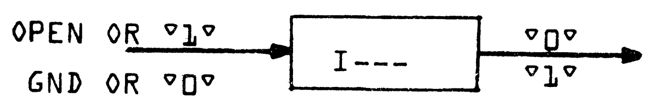
5. L CARD {69 CARD - OUTPUT}



6. M CARD {87 CARD - INPUT}



7. INVERTER



STUDY QUESTIONS

1. When recording by the NRZ1 method, which of the following is correct?

   a. All "one" bits in a particular track have the same polarity.

   b. All "zero" bits are of the same polarity as the "erased" portion of the tape.

   c. All "zero" bits on tape are of opposite polarity to all "one" bits on tape.

   d. All "one" bits on tape are of opposite polarity to the preceding one bit in the same channel.

2. A "track" on magnetic tape refers to

   a. The space separating adjacent heads.

   b. The scratches left on tape if recording head is misaligned.

   c. The longitudinal recording on tape caused by each individual head.

   d. The transverse positioning of bits.

3. In 60X recording format, a frame is composed of the following:

   a. Seven transverse data bits in tracks 0-6.

   b. Data recorded in tracks 0-5 with track 6 denoting parity.

   c. Track 0 being parity and tracks 1-6 containing data.

   d. Six data bits and a sprocket bit.

4. What is a "record" on tape?

   a. A group of frames covering 3/4 inches of tape.

   b. Data on tape resulting from one complete output from the computer.

   c. A specified length of tape on which data may be recorded.

   d. An octal 17 placed on tape to designate completion of a file.

5. What is the function of the load point and end-of-tape markers?

   a. Provide compatibility with other magnetic tape equipment.

   b. To index the beginning and end of the usable portion of the tape.

   c. To stop tape motion under certain conditions.

   d. All of the above are correct.

6. What is meant by the term "density"?

   a. The thickness of the oxide coating on the tape.

   b. The quality of the oxide material.

   c. The number of bits recorded per longitudinal inch in each track.

   d. The amount of tape on a full reel.

7. Which of the below represent acceptable density levels?

   a. 2400 feet @ 1.5 mils or 3600 feet @ 1 mil.

   b. 6 inches or 3/4 inches.

   c. 200 BP1, 556, BP1, or 800 BP1

   d. 5 level, 6 level, or 7 level

8. The file protect ring, installed on the supply reel, will:

   a. Disable write circuits, preventing data recording.

   b. Extinguish "overhead" lights signaling write function not possible.

   c. Enable write circuits, allowing data recording.

   d. Prevent unauthorized operators from using tape.

9. In regards to 60X tape format vertical parity, which of the following is correct?

   a. In BCD format, the parity bit is chosen to make total number of "one" bits <u>odd</u>.

   b. In binary format the parity bit is always a "one".

c. In binary format the parity bit is chosen to make total number of "one" bits even.

d. In binary format, if the 6 data bits contain even number of "ones", the parity bit will be a "one".

10. When set for BCD, which of the following words would be illegal?

a. 001001

b. 001111

c. 000000

d. None of the above.

11. In each and every "frame" there must be at least one recorded "one" bit. Why?

a. The sprocket bit is always present.

b. All zero's in BCD are illegal.

c. All zero's in binary would result in a "one" for parity.

d. b and c are both correct.

12. When set for "binary", which of the following would require a "one" for parity.

a. 000000

b. 010010

c. 011110

d. All of the above.

13. The load point marker is:

a. Placed on the base side of the tape near the edge away from the operator.

b. Placed 18 feet from the physical beginning of the tape.

c. Placed on the oxide side of the tape on the edge nearest the operator.

d. Placed 15 feet from the beginning of the tape on the edge nearest the operator and on the base side.

14. The end of tape marker is:

a. An aluminum strip placed 25 feet from the end of the tape.

b. Placed on the base side of the tape.

c. Placed on the edge away from the operator.

d. All of the above are correct.

15. Complete the following using non-return to zero, change on 1's (Binary format.)

Operation	Binary Representation	Flip-Flop
Clear Register	0 000 000	C CCC CCC
Write 25	0 010 101	C CSC SCS
Write 52		
Write 36		
Write 14		
Clear Register		

16. In the above, what will the check character be?

a. 1 5 5

b. 0 2 2

c. 1 2 2

d. 0 5 5

17. File protection rings are used to:

a. Enable the read circuits during a read operation.

b. Turn on overhead lights so operator can see to load tape.

c. Enable write circuits so write operation may be performed.

d. Disable erase head during write operation.

18. When tape is moving in a forward direction, which of the following is correct?

    a. Pressure is gated to the left capstan, vacuum to the right capstan, low vacuum to brake port.

    b. Vacuum is gated to the left capstan, pressure to the right capstan.

    c. Vacuum is gated to the left capstan, pressure to the right capstan, and low vacuum to the brake port.

    d. Pressure is gated to both capstans and a high vacuum is gated to the brake port.

19. During a high density (556 BPI) write operation, what is the length of time required to write one frame?

    a. 33 microseconds

    b. 48 microseconds

    c. 12 milliseconds

    d. 12 microseconds

20. During a write operation, write current is approximately:

    a. 60 microamps

    b. 30 milliamps

    c. 40 milliamps

    d. 60 milliamps

21. Which of the following statements concerning the approximate start - stop times is correct?

    a. Stop time of 2 milliseconds, start time of 3 milliseconds.

    b. Stop and start time are both 3 milliseconds.

    c. Start time is 3 milliseconds, stop time is 4 milliseconds.

    d. Start time is 2 milliseconds, stop time is 3 milliseconds.

22. Why is it necessary to have vacuum buffer columns of the tape unit?

a. Start/stop time of reel drive units too slow.

b. Damage to tape if capstans pulls tape directly from reel.

c. Rapid direction change would stretch or break tape.

d. The amount of tape a reel drive unit could handle per second varies with the amount of tape wound on the reel.

e. All of the above are correct.

23. The 60X Magnetic Tape unit data transmission is:

a. Twelve bits plus parity bit.

b. Six or twelve bits plus parity bit.

c. Six data bits plus parity bit.

d. Depends on computer being used.

24. The 60X delivers which of the following groups of signals to the controller?

a. Write ready, end of tape, write sprocket.

b. Write ready, high density selected, read sprocket.

c. End of operation, low density selected, end of tape.

d. Read select, read sprocket, load tape.

25. The "busy" signal notifys the controller that:

a. The tape unit is performing a local write.

b. The tape unit is doing "off line" operation.

c. Tape is in motion.

d. None of the above.

26. The Read Sprocket signal from the tape unit to the controller:

a. Synchronizes the data input with the controller.

b. Is produced only when a frame contains at least one "1" bit.

c. Is produced in the tape transport.

d. All of the above.

27. Which of the following statements concerning the write sprocket are correct?

a. The write sprocket is recorded as a data bit in track 7.

b. The write sprocket is generated by the tape unit write circuitry.

c. The write sprocket is a timing pulse generated by the controller.

d. None of the above.

28. The write ready signal to the controller signifys that:

a. A tape has been written successfully.

b. A write operation is already in progress.

c. The file protect ring is in place and a write operation may be performed.

d. The file protect ring has been removed and a write operation may be performed.

29. Gating pressure or vacuum to the capstans is controlled by:

a. Tachometer circuits.

b. Servo drive circuits.

c. Motion flip flops, K400/401 & K402/403.

d. The high speed relay.

30. If a fault condition occurs, which of the following is true?

a. Motion will continue but the busy signal will drop.

b. Low vacuum will be applied to the brake port.

c. Motion stops and reel brakes are applied.

d. K113 will enable drive pulses to tape reels.

31. Immediately after setting K402/403, which of the following occurs?

   a. I407 will output a "0".

   b. I408 will output a constant "1".

   c. I408 will output a constant "0"

   d. I408 will output a "0" for a period of 2 milliseconds.

   e. I408 will outut a "0" for a period of 1.5 milliseconds.

32. Which of the following is a true statement about the "busy" signal?

   a. The busy signal is a 5 msec pulse to the

   b. When tape is moving the busy signal is sent out as a 5 millisecond pulse.

   c. When tape is in motion a constant busy signal is sent to the controller. It will drop 5 milliseconds after motion stops.

   d. The busy signal will not be sent during rewind.

33. For a period of 2 milliseconds after K400/401 is set, which of the Y--- transistors will be conducting?

   a. Y429, Y428, Y427, Y434, Y431, Y430

   b. Y424, Y421, Y420, Y434, Y433, Y432

   c. Y429, Y426, Y425, Y434, Y433, Y432

   d. Y434, Y433, Y432, Y429, Y428, Y427

34. Depressing the "forward" switch on the maintenance panel when the tape unit is "ready" will cause:

   a. M402 to output a "1" pulse setting the forward FF.

   b. M400 will output a "1" setting K400/401.

   c. No action due to the "and" gate out of M402 being disabled.

   d. A fault condition to occur.

35. Immediately after clearing K400/401:

a. Pressure will be applied to both capstans and the brake port.

b. Pressure is applied to the forward capstan and high vacuum to the brake port.

c. Pressure is applied to the reverse capstan and low vacuum to the brake port.

d. Pressure is applied to the forward capstan, vacuum is applied to the reverse capstan, and high vacuum to the brake port.

36. Erroneously a write/reverse signal is sent to the 606, what will happen?

a. Tape would not move due to I537 breaking the "and" gate to I401.

b. A fault condition will exist and tape will not move.

c. The tape will move in reverse at 150 inches per second but no data will be written.

d. Data will be written but will have to be read also in reverse.

37. In a forward motion, tape speed out of the buffer column increases, the voltage at J204-X will:

a. Increase in a positive direction.

b. Increase in a negative direction.

c. Only affect the operation in rewind.

d. Cause the forward capstan speed to increase.

38. When K102/103 (Page 2-7-6) sets, what effect does it have on the servo drive control circuitry logic?

a. Permits CW drive of supply reel to load right hand vacuum chamber.

b. Causes brakes on both reels to be released.

c. Disables the tachometer circuit while tape is in rewind.

d. Prevents CCW drive of take up reel, effectively locking reel, during loading.

39. Refer to take up reel photosense circuits. If tape in left hand column is above both photocells which of the following is correct?

    a. "1" input into Y305 and Y306, applying brake.

    b. "1" input into Y305 and Y306, driving CCW.

    c. "0" input into Y305 and Y306, applying brake.

    d. "1" input into Y307 and Y306, driving CW.

40. In high speed operation tape speed is controlled by:

    a. The tachometer circuit.

    b. Varying the speed of the capstan.

    c. Intermittent gating of vacuum and pressure to the reverse capstan.

    d. Intermittent gating of vacuum to the brake port.

41. Setting K400/401 and K402/403 at the same time is:

    a. Impossible unless component failure occurs.

    b. Possible under certain selected conditions.

    c. Possible but will cause a fault condition.

    d. Normal procedure when changing direction of tape travel.

42. What will happen if forward command drops during write operation?

    a. Tape will continue until complete record is completed.

    b. The forward FF will clear stopping tape motion.

    c. I404 output will be a "1" preventing K400/401 from being cleared.

    d. Normal operation continues.

43. During a write operation an end of tape indicator is sensed. The 606 will:

    a. Stop immediately.

    b. Stop at end of record.

    c. Automatically rewind to load point.

d. Stop if operator terminates the write.

44. Having the file protect ring in place allows the 606 to:

    a. Enable erase head.

    b. Supply write head current.

    c. Send the controller a ready to write signal.

    d. All of the above.

45. The purpose of the file protect solenoid is to:

    a. Hold the file protect ring in place.

    b. Retract file protect switch from hub.

    c. Turn on overhead lights.

    d. Allow write operation if file protect ring is forgotten.

46. Inverters I008 and I016: (Write Control)

    a. Prevent write current from flowing in the write heads during a Read operation.

    b. Clear the write register at the start of a new record.

    c. Help bias the Read Level during a Write operation.

    d. Clear the write register when a Write operation terminates.

47. The tape unit is reading a reel of tape that has the file protect ring properly in place. Which of the below is a correct statement?

    a. The erase and write heads are disabled due to K203.

    b. The erase and write heads are disabled due to the effect of the dummy load R216.

    c. The erase and write heads are not disabled but a write enable into M008 is necessary for writing.

    d. The erase heads are enabled regardless of K070/071.

48. What determines the density at which frames are recorded on tape?

a. Rate of signal at J208-J.

b. Rate of signal at J209-K.

c. Rate of signal at J208-T.

d. Rate of signal change at J208-A thru H

49. What is the purpose of the individually adjustable UCB card?

a. Insure that the sprocket pulses are of the proper voltage level.

b. Delay sprockets to insure data will be aligned vertically on tape.

c. They are adjusted to delay data in low density.

d. None of the above.

50. How long does information remain in rank 1 during a write operation?

a. 3 microsec

b. 5 microsec

c. 1 microsec

d. Not possible to determine with the information furnished.

51. How long does information remain in rank 2 during a read operation?

a. 2 microsec

b. .5 microsec

c. 1 microsec

d. 5 microsec

52. What is the duration of the Read sprocket pulse?

a. 2 microsec

b. 4 millisec

c. 4 microsec

d. Depends on density selection.

53. Which of the following statements about the end of operation are correct?

   a. End of operation is a 200 usec signal.

   b. End of operation is a 10 usec signal transmitted after each frame.

   c. End of operation signal is transmitted only after file mark is detected.

   d. End of operation is a 10 usec signal trasmitted 200 usec after last frame of a record.

54. What is the purpose of the delay Y551?

   a. To hold stop command a sufficient length of time.

   b. To allow a non-stop read operation.

   c. Delay sending out the clear motion FF signal.

   d. Delay clearing motion in reverse.

55. Due to malfunction K574/575 is constantly clear. During a search file mark command tape motion will:

   a. Stop when file mark is read.

   b. Not stop.

   c. Stop with normal end of record.

   d. Stop immediately

56. During a write operation the input from Y010 will:

   a. Decrease the negative bias to the EIB cards.

   b. Have no effect on the EIB cards.

   c. Increase the negative bias to the EIB cards.

   d. Disable read circuits during write.

57. Y549 delay:

   a. Assures that Y548 has timed out before a stop signal is sent.

   b. Delays the End of Operation signal until Stop on File Mark FF has cleared.

c. Disables I562 while a record is being read.

d. Causes End of Operation pulse to be 10 usec in duration.

58. When reading to verify during a write operation, the delay in gating rank I into rank II of the read register is:

a. 0.5 microsec due to capacitor input to I506.

b. 5 usec due to constant zero out Y543.

c. 14 usec due to enables on input gates to both Y541 and Y542.

d. Dependent on Density selected.

59. When reading in high density, the minimum delay in gating rank I to rank II of the read register is:

a. 5 usec.

b. 2 usec.

c. 9 usec.

d. 14 usec.

60. Which of the choices for item 59 would apply when reading a low density tape?

a.

b.

c.

d.

e. None of them.

61. The output of I539 will be a logic "1" when:

a. A write operation is enabled and selected, tape unit is ready.

b. Tape unit is ready, rewind from TCU, and output of I123 is correct.

c. Tape unit is ready, rewind unload from TCU, and output of I123 is correct.

d. Any of the above conditions are present.

62. What is the purpose of Y543?

a. Hold the read register clear during initial tape acceleration.

b. Clear read register during stop time.

c. Allows data to arrive in rank 1 during hi density read.

d. Allows read reverse to be performed.

63. The 10 microsecond end of operation pulse signals the synchronizer that:

a. An end of record located and stop on file mark not selected.

b. File mark located and stop on file mark selected.

c. Load point detected during rewind operation.

d. Any of the above conditions exist.

CHAPTER VI

ELECTRICAL ADJUSTMENTS

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ELECTRICAL ADJUSTMENTS

SPACER BARS

The card spacer bars on the logic chassis must be carefully installed after electrical adjustments to prevent electrical shorting between logic cards. The spacer bars are designed to hold the logic cards snugly in place with a minimum of card side play.

Spacer bars are of two types, odd and even. Even bars have card holding projections starting at the very end of the bar. Odd spacers have card holding projections starting about 1/8 of an inch from the end.

When installing the bars, always start with an odd bar in the top row of the chassis and alternate odd-even-odd to the bottom of the chassis. Place the bars in position and tighten holding screws to hold bars loosely in place. Make sure all holding projections are between cards. Slide even spacer bars to the right and tighten securely. Slide odd spacer bars to the left before tightening. The logic cards must be held securely.

AMPLIFIER CARD ADJUSTMENT

Begin this adjustment by writing a tape with all "1's". While writing observe test point C of all level detection cards (locations G02, G04, G06, G08, G10, G12 and G14) for a negative-going rectified signal of 8 volts peak to peak. If necessary, adjust the associated preamplifier cards located in the head termination package (X02 through X08) for the desired 8 volt peak to peak signal at G02, G04, G06, G08, G10, G12, and G14.

READ ADJUSTMENTS

1. Load a master tape (556 BPI) on the tape transport.

CAUTION

> Do not rewind the master tape at high speed. Stop the master tape only at the end of tape or Load point marker.

2. MECHANICAL SKEW

a. Perform a forward read operation and sync the scope on test point A of G08. Simultaneously, compare the waveform from test point A of G02 with that received from test point A of G08 for any offset or difference in time. If an offset condition exists, adjust the wobble plate until the two waveforms are as close as possible to same phase relationship. Sync on TPA of G02; observe TPA of G04, G06, G08, G10, G12 and G14 to verify that they are all approximately in phase.

b. Perform a second forward read operation and sync the scope negative on test point C of G08. Simultaneously compare the output waveform of F10C with that received from F16C. Adjust the two positioning screws until the two set outputs appear to be going to a 1. Make sure that both screws are secure at the end of this adjustment.

3. ELECTRICAL SKEW ADJUSTMENTS

a. Perform a third forward read operation and sync the scope positive on test point C of F10C. Observe the test point of E01 and adjust the delay until the output from E01 goes positive (to 0) 3 microseconds after test point C of F10C goes positive. Perform the same adjustment for the remaining six flip-flops (F11C through F16C) of Rank I (delay cards E02 through E07 respectively).

b. Perform a fourth forward read operation and sync the scope on the G07 (TPC). Observe and record the skew of all tracks at the output of the forward delays (E01-E07). The maximum time difference between any two tracks should be no greater than 1.5 microseconds.

c. With the sync at G08 (TPA), observe the delay outputs (E01-E07). Determine which track goes to zero last.

d. Observe the latest track on one sweep. Adjust the remaining six tracks (locations E01 through E07) until outputs go to zero at the same time as the reference track.

e. Remove the master tape.

NOTE

Switch S220 (Level Shift Network) should be in the Normal position during read operations. However, when reading tapes with weak signals, move the switch to the -10% or -20% position to lower the threshold reference voltage to the level detector card. When reading tapes that are noisy, move S220 to the +10% position to increase the threshold reference voltage. When changing from marginal tape to regular tape, return the switch to the Normal position.

READ GATE CONTROL ADJUSTMENT

1. Read a tape which has been recorded at 200 bpi.

2. Sync positive on E16A and adjust F19 for a 2 usec delay.

3. Adjust F20 for 9 usec additional delay. (11 usec total)

WRITE ADJUSTMENTS

1. The write adjustments must be performed while writing all "1's" on a tape. Sync the scope negative on I010, (C12C), observe and adjust C01, C02, and C03 until each has a 3 microsecond delay. Move the sync point to I009 (C12A), observe and adjust C04, C05, C06 and C07 until each has a 3 microsecond delay.

2. Sync the scope on the class A signal of track 3 (G08) and observe the skew on all tracks at the outputs of the forward track delays to determine which track goes to zero first.

3. Observe the latest track in one sweep while it goes from 0 to 1. Adjust the remaining six tracks (C01-C07) (TPC) until the outputs of E01 through E07 go to zero at the same time. After this adjustment, the total time delay for each delay card (C01 through C07) should be between 3 and 4.5 microseconds.

START/STOP TIME INSPECTION

Load a tape containing all "1's". Make the following setting with the aid of a Tektronix 543, or equivalent, oscilloscope.

Horizontal:	1 msec/cm
Vertical:	1 v/cm
Trigger Selector	External

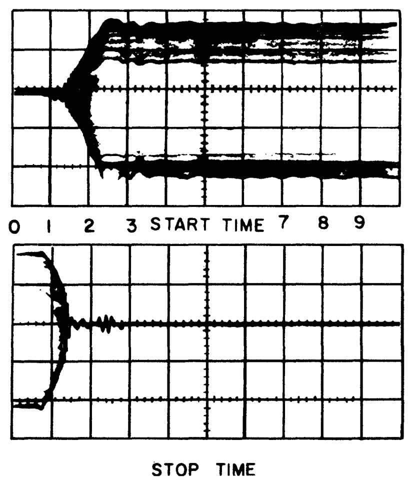
The forward start/stop time can be checked as follow:

1. Connect the oscilloscope Trigger Selector input to the set output of the Forward FF (C32, test point C).

2. Observe the class A signal at test points A and B of the level detector card, location G08.

3. Alternately depress the Forward and Clear switches on the maintenance panel. The time interval following the forward command until output from the channel being observed reaches maximum should be 2.25 to 3.25 milliseconds. The tape should start to accelerate approximately 1.5 milliseconds after the forward command. Refer to the scope traces shown in Figure 2-6-1.

4. The time interval following the stop command until the output of the channel being observed drops to zero should not exceed 2.0 milliseconds. Refer to Figure 2-6-1.



OSCILLOSCOPE SETTINGS

HORIZONTAL— 1msec/cm
VERTICAL — 1 v/cm

Figure 2-6-1. Typical Start/Stop Time

START/STOP TIME ADJUSTMENT

Proceed with start/stop time adjustment as follows:

NOTE

Use a CONTROL DATA® 699 Tape Transport Exerciser on start/stop mode or the tape control unit to generate a high cycle rate.

1. Close the pressure relief valve, located on the tape deck manifold.

2. Using a new section of tape (with less than 20 total passes), operate the transport in a start/stop mode at approximately 100 cps. Adjust the relief valve to obtain 2.25 to 2.75 msec start time in both forward and reverse directions. This time applies to the intersection of the start envelope and average 100% amplitude level (Figure 2-6-2). Check the start time, forward and reverse, at approximately 20 cps. The start time should be within the range of 2.25 to 2.75 msec.

3. Using a tape having a minimum of 200 total passes, recheck the start times for both high and low cycle rates in both forward reverse directions. All start times should be within the range of 2.25 to 2.75 msec. The stop time should be within 1.75 to 2.75 msec (Figure 2-6-3).

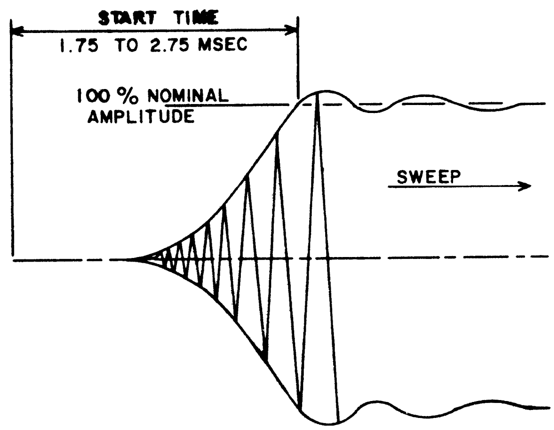


Figure 2-6-2. Start Time

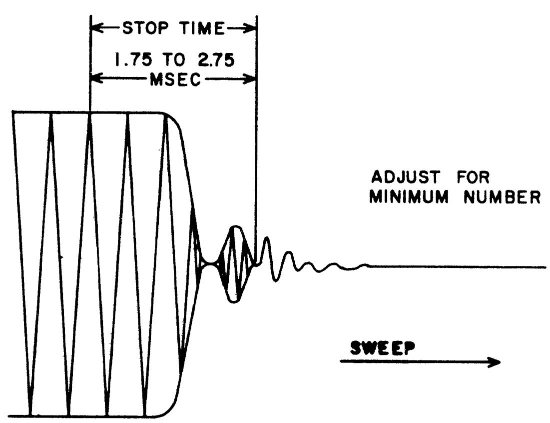


Figure 2-6-3. Stop Time

1. ADJUST ALL PHOTOCELL CARDS 'OAA' AS FOLLOWS:

A. Adjust loop box lamps for optimum focusing. (4 lamps)

1. Remove amplifier card associated with the lamp to be focused, and insert card extender. Do not insert the card.

2. Connect a milliammeter between pins 1 and 2 (or pins 7 and 8 for section C of card).

3 Loosen set screw on lamp holder and rotate or slide to focus lamp for maximum photocell output current reading (typically between 1/2 and 3 ma depending on lamp, photocell, meter, etc.) for maximum reading. Tighten the set screw.

4. Replace photocell amplifier card.

B. Adjust photocell amplifier card

Loop box photocells

1. Load tape.

2. Simulate an unload condition by simultaneously depressing the 'CLEAR' and 'UNLOAD' switches on the operator or maintenance panel. The tape loops may now be moved to either cover or uncover the photocell lamps for the adjustment of the photocell amplifiers.

3. Observe the output of the amplifier card to be adjusted with an oscilloscope.

4. With the photocell covered, turn the amplifier card potentiometer counterclockwise until the output goes to a '1'.

5. Turn the potentiometer clockwise to the point where the output switches to a '0'.

6. Make the final adjustment by turning the potentiometer 3 turns (360 degrees per turn) clockwise.

7. Uncover the photocell. The output should switch to a '1'. Move the tape loop up and down to cover and uncover the photocell repeatedly and verify that the output switches from '0' to '1'. Cover = '0'. Uncover = '1'.

8. Repeat steps 3 through 7 of loop box photocell adjustment for the remaining three loop box photocell amplifiers.

Load point and EOT photocell

NOTE

> Use a piece of magnetic tape with the reflective marker attached to the mylar side in the following procedure.

1. Place the mylar side of the tape over the photocell sensor assembly to cover the photocell. This will prevent light from energizing the photocell. The reflective marker is to be nearest the operator and not over the photocell sensor for adjusting the LP photocell amplifier.

2. Observe the output of the amplifier card to be adjusted with an oscilloscope.

3. With the photocell covered, turn the amplifier card potentiometer counterclockwise until the output goes to a '1'.

4. Turn the potentiometer clockwise to the point where the output switches to a '0'.

5. Make the final adjustment by turning the potentiometer 4 turns (360 degrees per turn) clockwise.

6. Move the reflective marker over the photocell sensor assembly. The output should switch to a '1'. Alternately slide the reflective marker over, and off of the photocell sensor assembly, and verify that the output switches from a '1' to a '0'. Reflective marker over = '1'. Mylar over = '0'.

7. Turn the tape around to adjust the end of tape photocell amplifier, the reflective marker is off of the photocell sensor assembly.

8. Repeat steps 2 through 6 of the load point and EOT photocell adjustments.

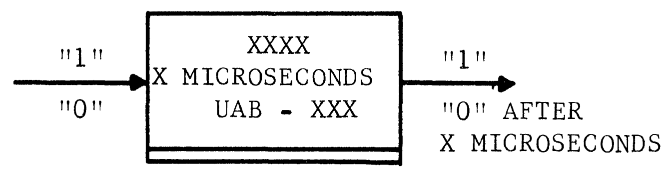
CHAPTER VII

LOGIC DIAGRAMS

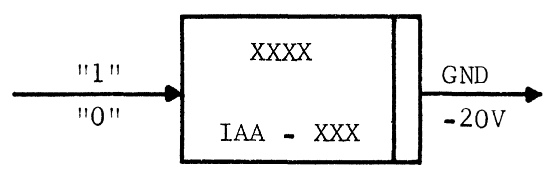
LOGIC DIAGRAMS

Special Modules

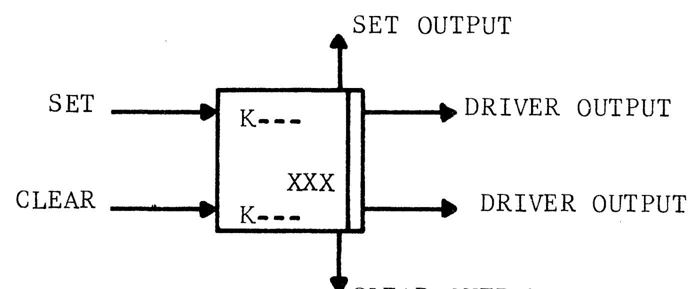
UAB - ADJUSTABLE DELAY

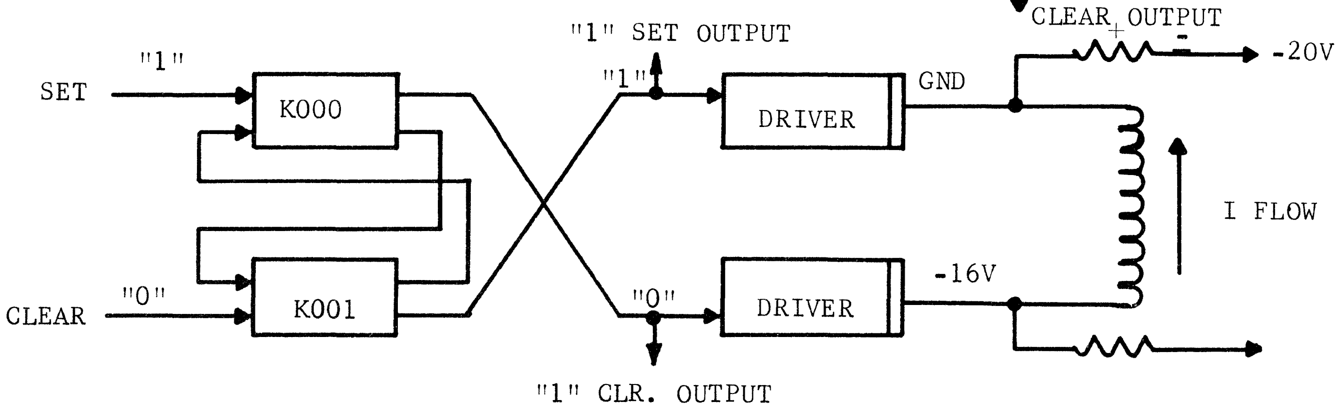


IAA, IAB - RELAY PULLER

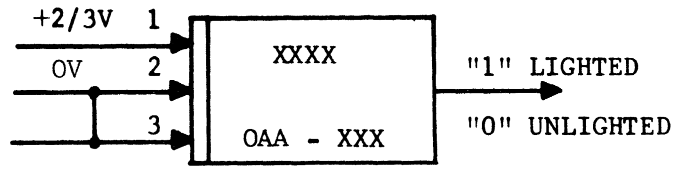


IJA - FLIP-FLOP WRITE DRIVER

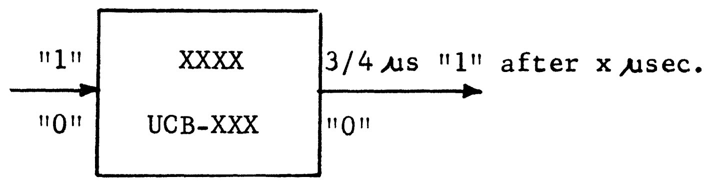




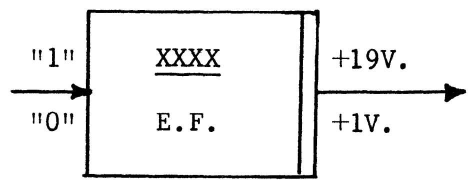
OAA - PHOTOCELL AMPLIFIER

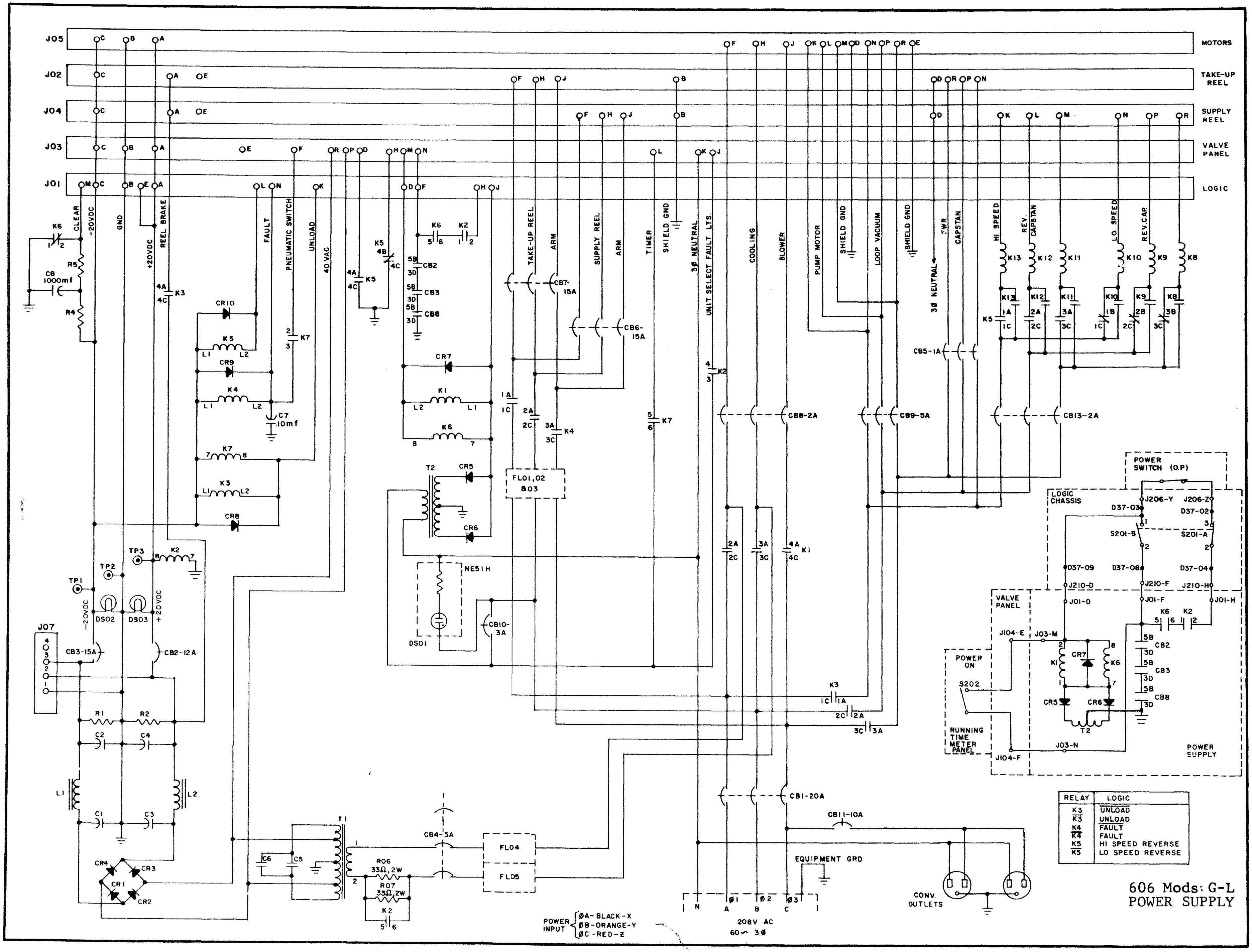


UCB - Adjustable Pulse Delay



IBA - Emitter Follower

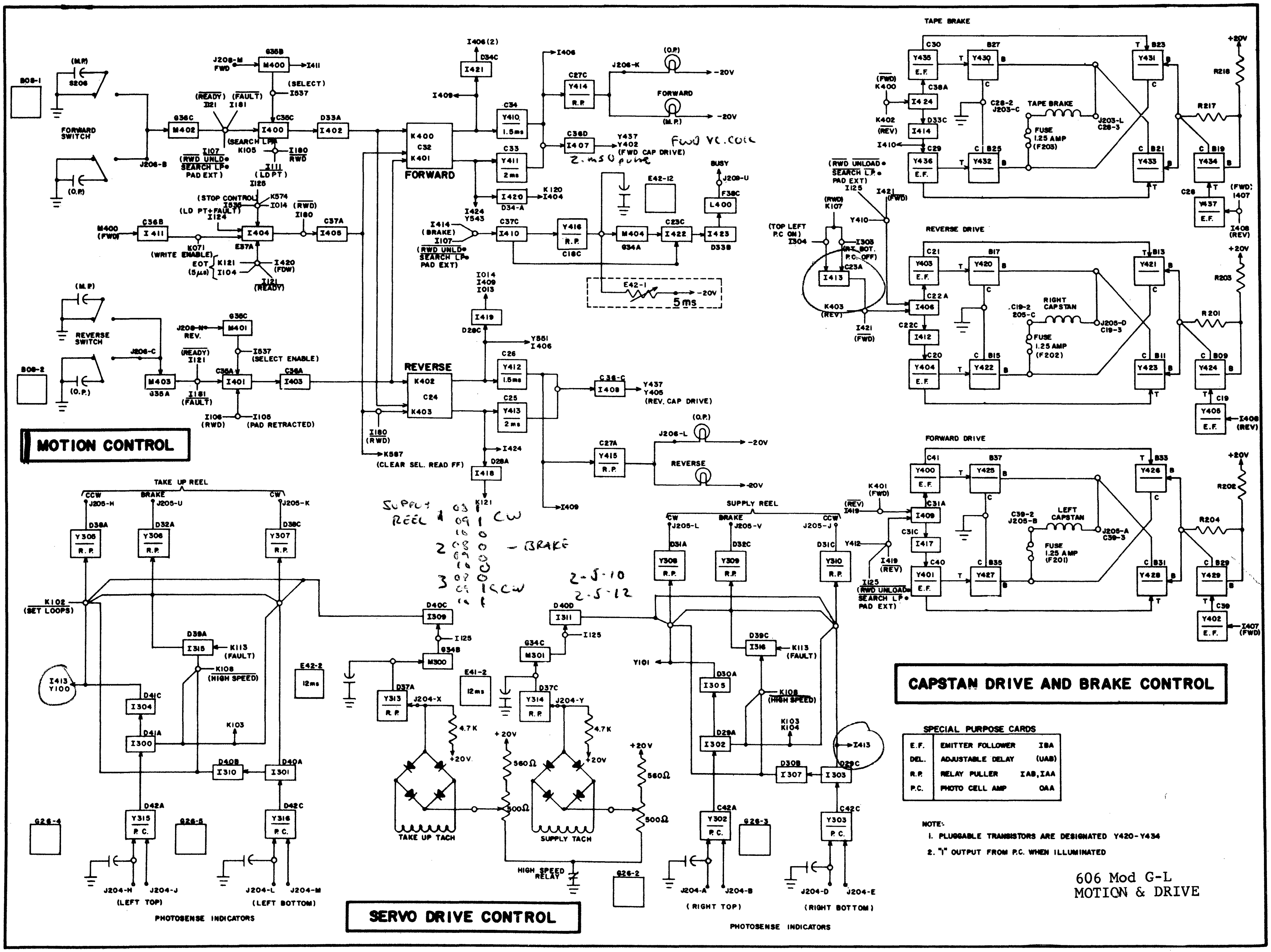


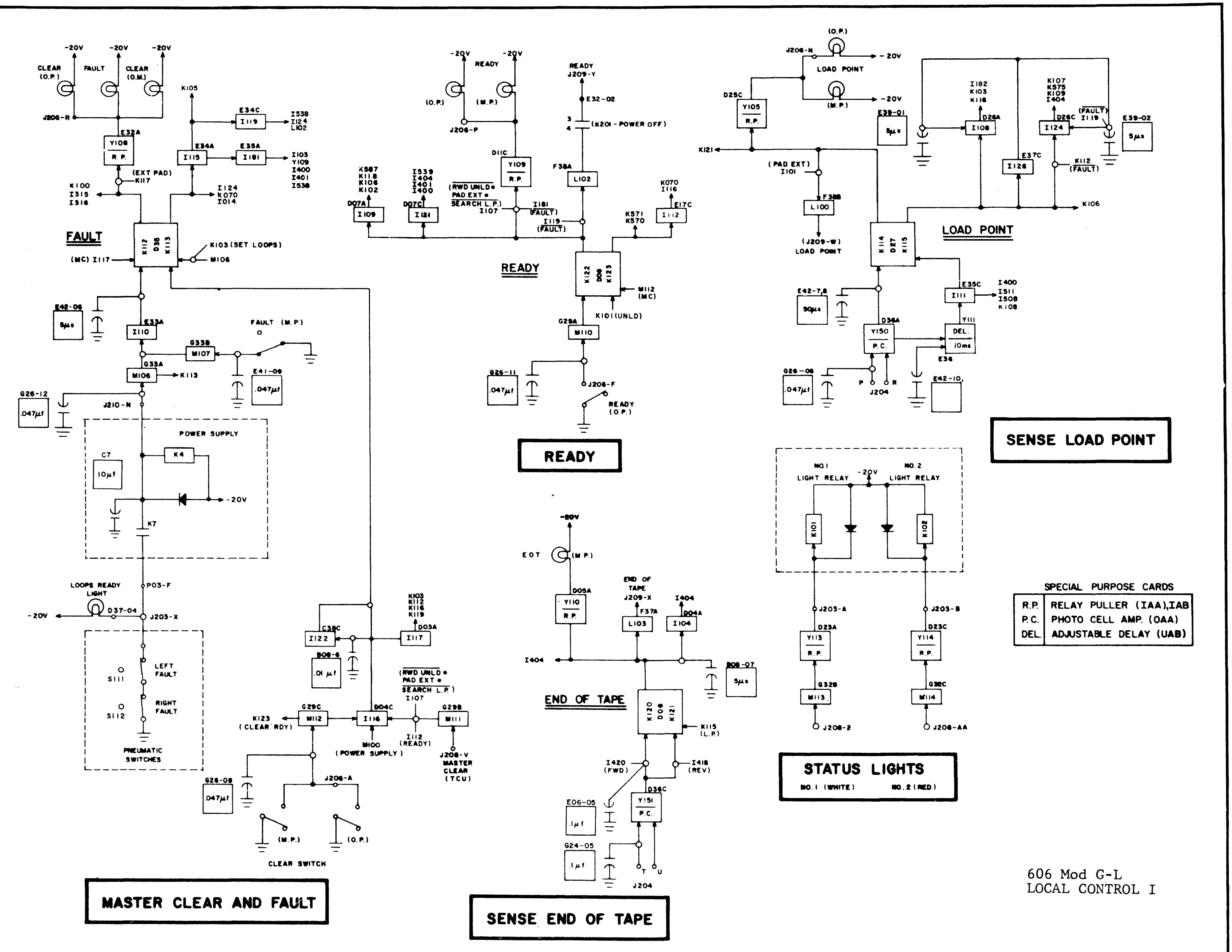


RELAY	LOGIC
K3	UNLOAD
$\overline{K3}$	UNLOAD
K4	FAULT
$\overline{K4}$	FAULT
K5	HI SPEED REVERSE
$\overline{K5}$	LO SPEED REVERSE

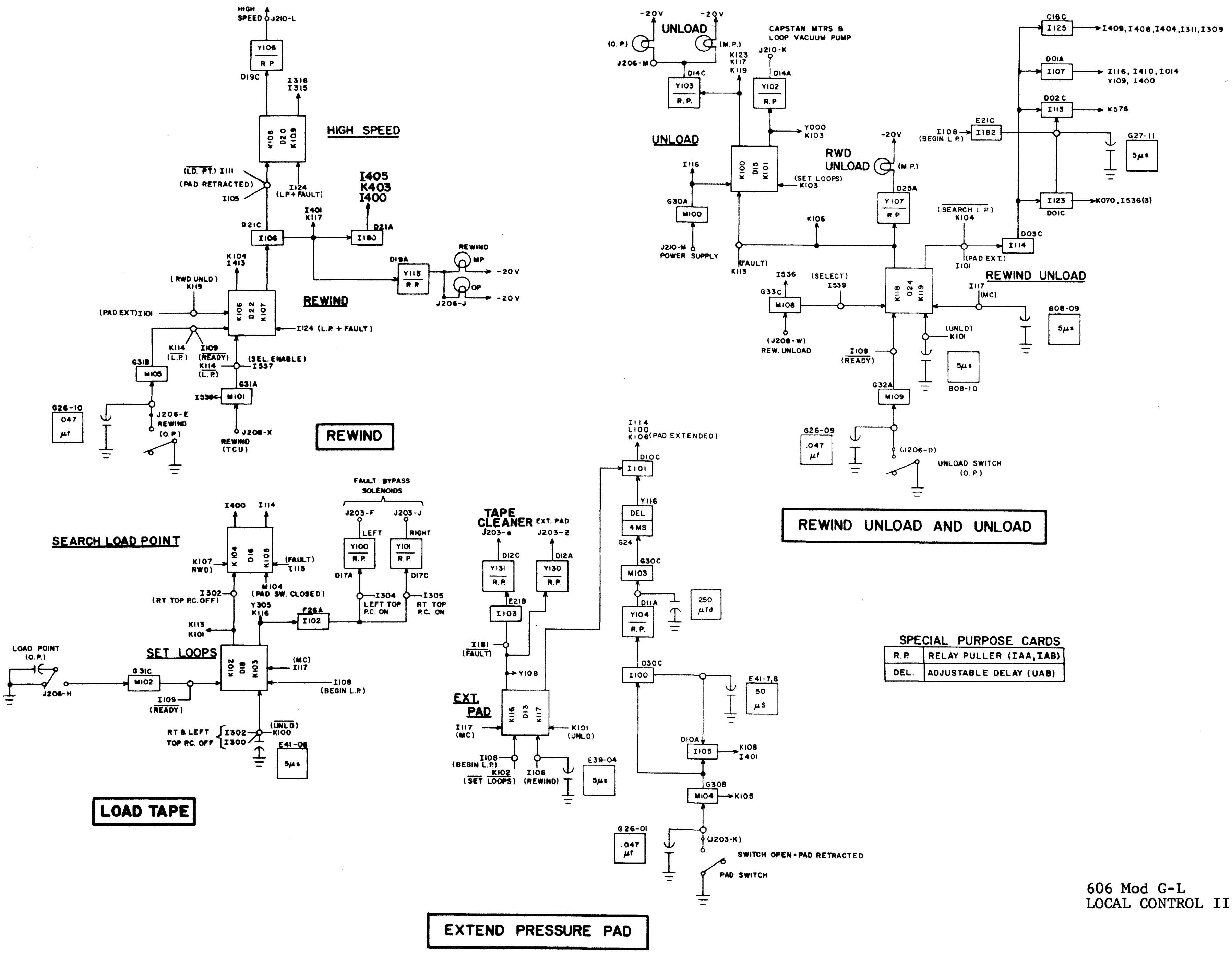
606 Mods: G-L
POWER SUPPLY

A X BLACK GREEN OR WHITE GROUND - NEUTRAL
B Y RED


MOTION CONTROL
SERVO DRIVE CONTROL
CAPSTAN DRIVE AND BRAKE CONTROL
TAPE BRAKE
REVERSE DRIVE
FORWARD DRIVE
FORWARD SWITCH
REVERSE SWITCH
FORWARD
REVERSE
TAKE UP REEL
SUPPLY REEL
TAKE UP TACH
SUPPLY TACH
HIGH SPEED RELAY
PHOTOSENSE INDICATORS
SPECIAL PURPOSE CARDS
E.F. EMITTER FOLLOWER ISA
DEL. ADJUSTABLE DELAY (UAB)
R.P. RELAY PULLER IAB, IAA
P.C. PHOTO CELL AMP OAA
NOTE:
1. PLUGGABLE TRANSISTORS ARE DESIGNATED Y420-Y434
2. "1" OUTPUT FROM P.C. WHEN ILLUMINATED
606 Mod G-L
MOTION & DRIVE



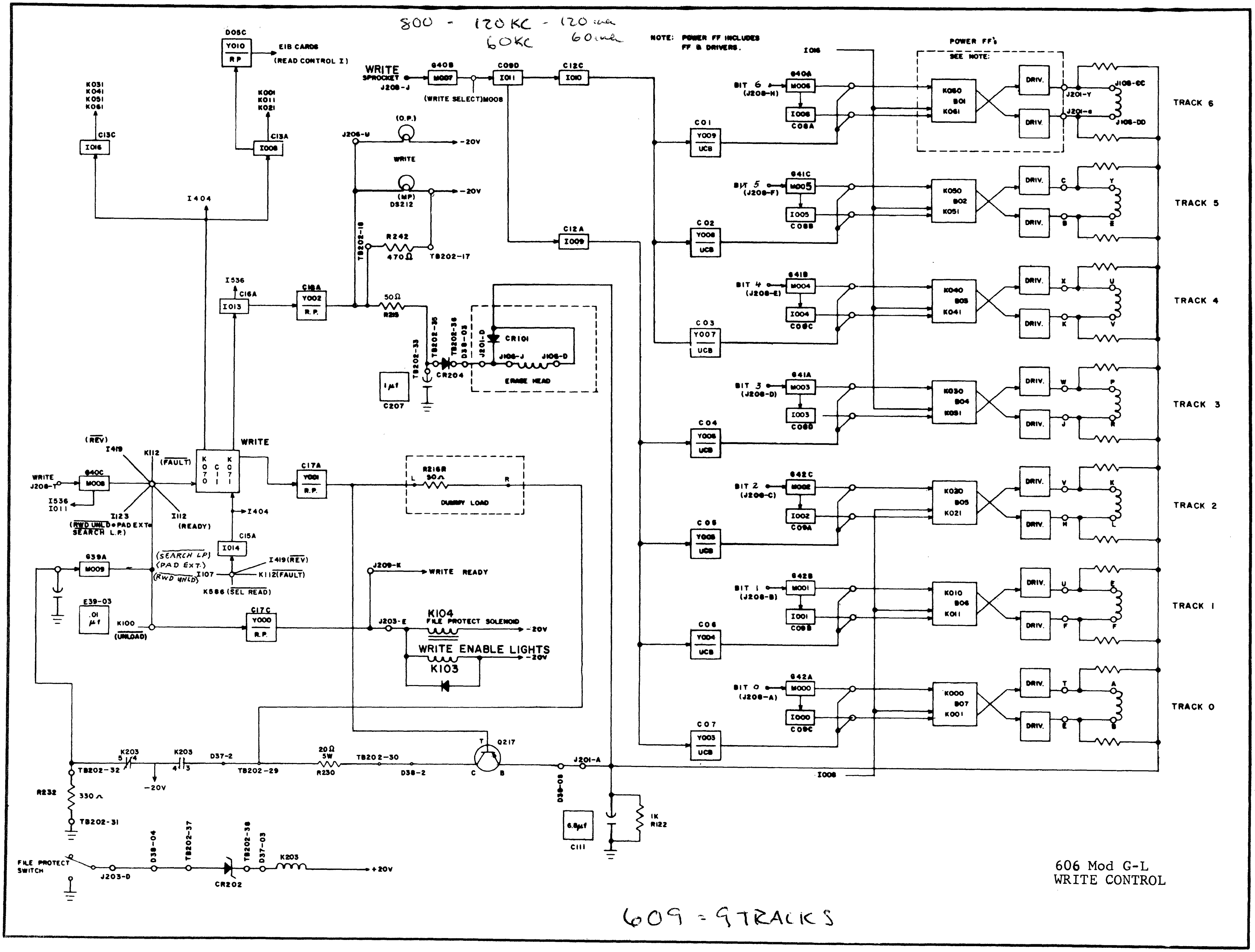
MASTER CLEAR AND FAULT
FAULT
POWER SUPPLY
PNEUMATIC SWITCHES
CLEAR SWITCH
LOOPS READY LIGHT
READY
SENSE END OF TAPE
END OF TAPE
SENSE LOAD POINT
LOAD POINT
STATUS LIGHTS
NO. 1 (WHITE)
NO. 2 (RED)
NO. 1 LIGHT RELAY
NO. 2 LIGHT RELAY
SPECIAL PURPOSE CARDS
R.P. RELAY PULLER (IAA), IAB
P.C. PHOTO CELL AMP. (OAA)
DEL. ADJUSTABLE DELAY (UAB)
606 Mod G-L
LOCAL CONTROL I



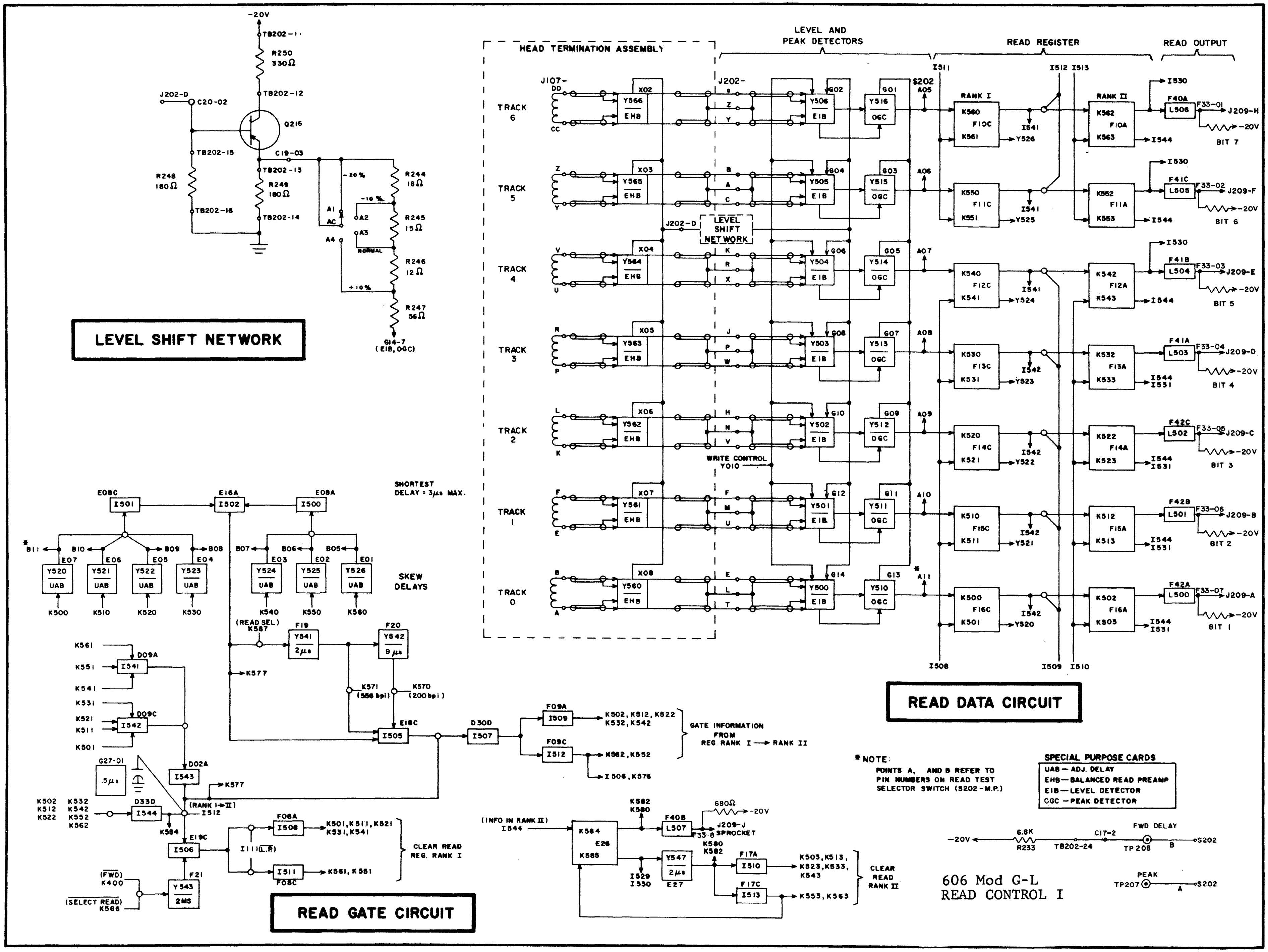
SPECIAL PURPOSE CARDS

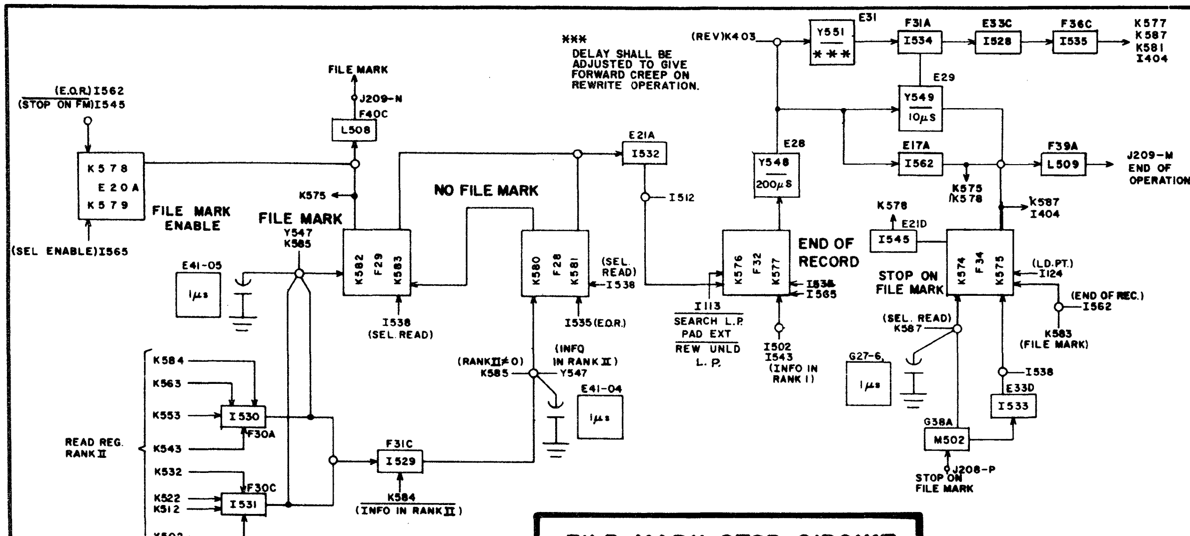
R.P.	RELAY PULLER (IAA, IAB)
DEL.	ADJUSTABLE DELAY (UAB)

606 Mod G-L
LOCAL CONTROL II

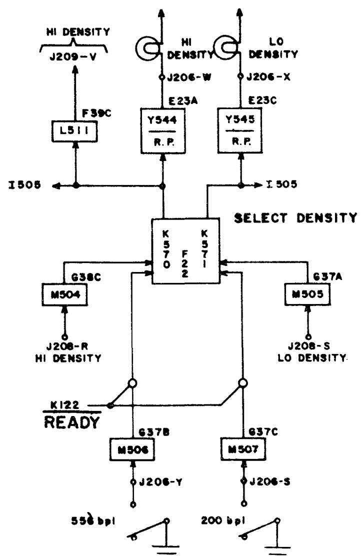


606 Mod G-L
WRITE CONTROL

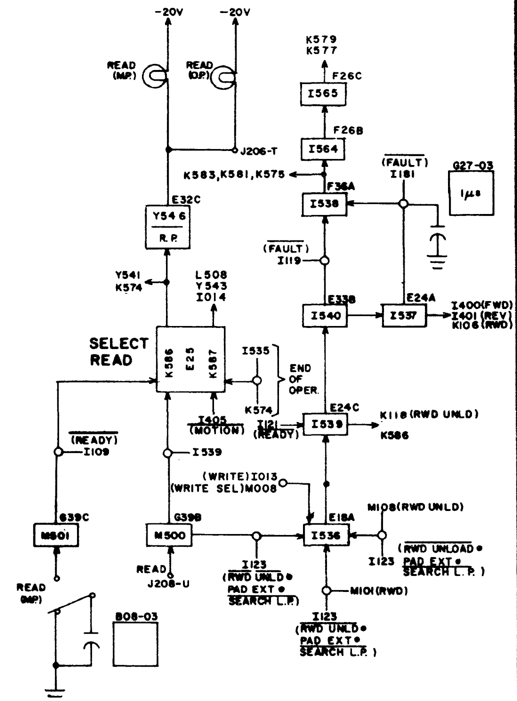

LEVEL SHIFT NETWORK
READ DATA CIRCUIT
READ GATE CIRCUIT
HEAD TERMINATION ASSEMBLY
LEVEL AND PEAK DETECTORS
READ REGISTER
READ OUTPUT
RANK I
RANK II
TRACK 6
TRACK 5
TRACK 4
TRACK 3
TRACK 2
TRACK 1
TRACK 0
BIT 7
BIT 6
BIT 5
BIT 4
BIT 3
BIT 2
BIT 1
WRITE CONTROL Y010
SHORTEST DELAY = 3μs MAX.
SKEW DELAYS
GATE INFORMATION FROM REG. RANK I → RANK II
CLEAR READ REG. RANK I
CLEAR READ RANK II
* NOTE:
POINTS A, AND B REFER TO PIN NUMBERS ON READ TEST SELECTOR SWITCH (S202-M.P.)
SPECIAL PURPOSE CARDS
UAB — ADJ. DELAY
EHB — BALANCED READ PREAMP
EIB — LEVEL DETECTOR
OGC — PEAK DETECTOR
FWD DELAY
PEAK
606 Mod G-L
READ CONTROL I



FILE MARK STOP CIRCUIT



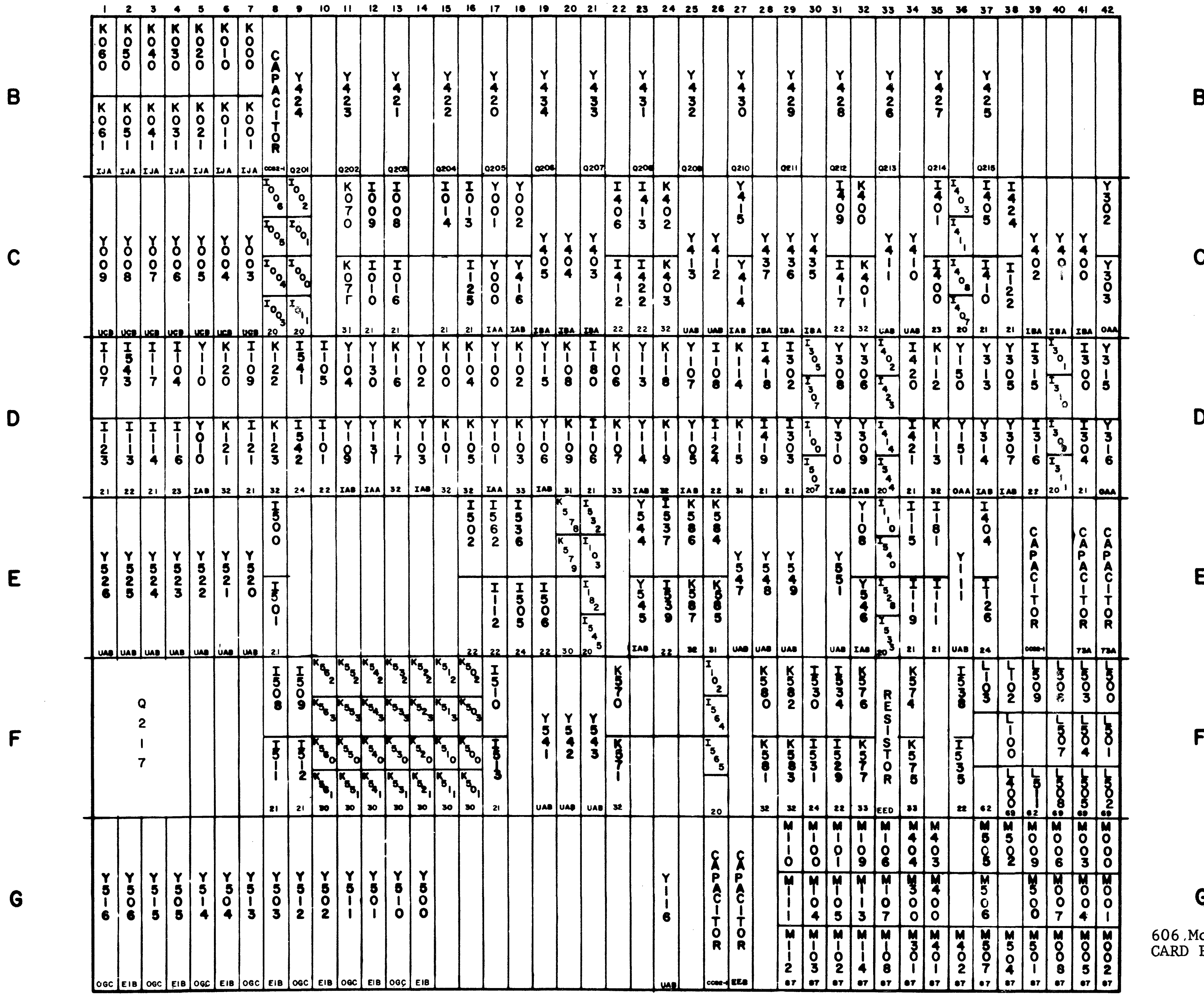
SELECT DENSITY CIRCUIT



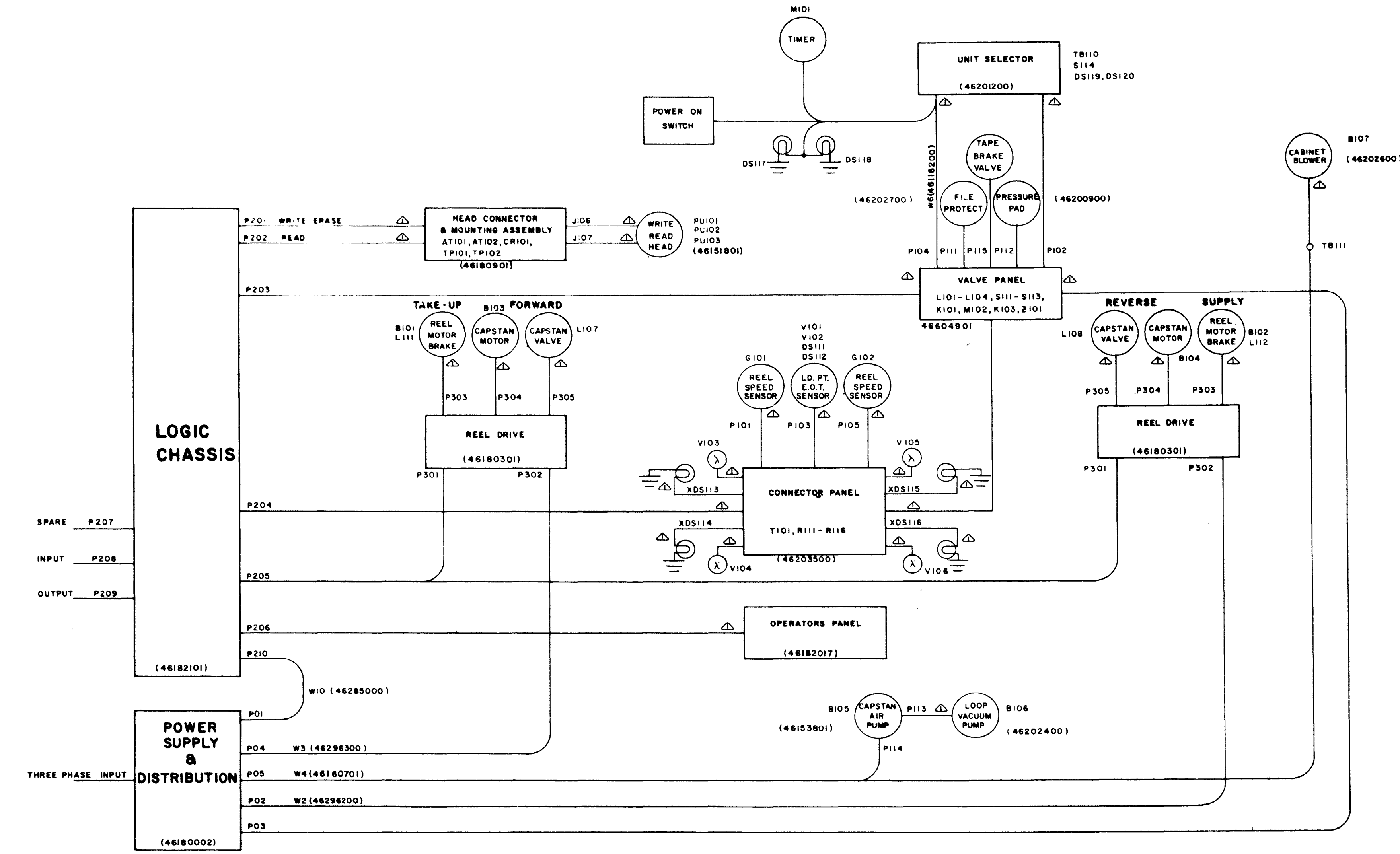
SELECT READ

606 Mod G-L
READ CONTROL II

2-7-10

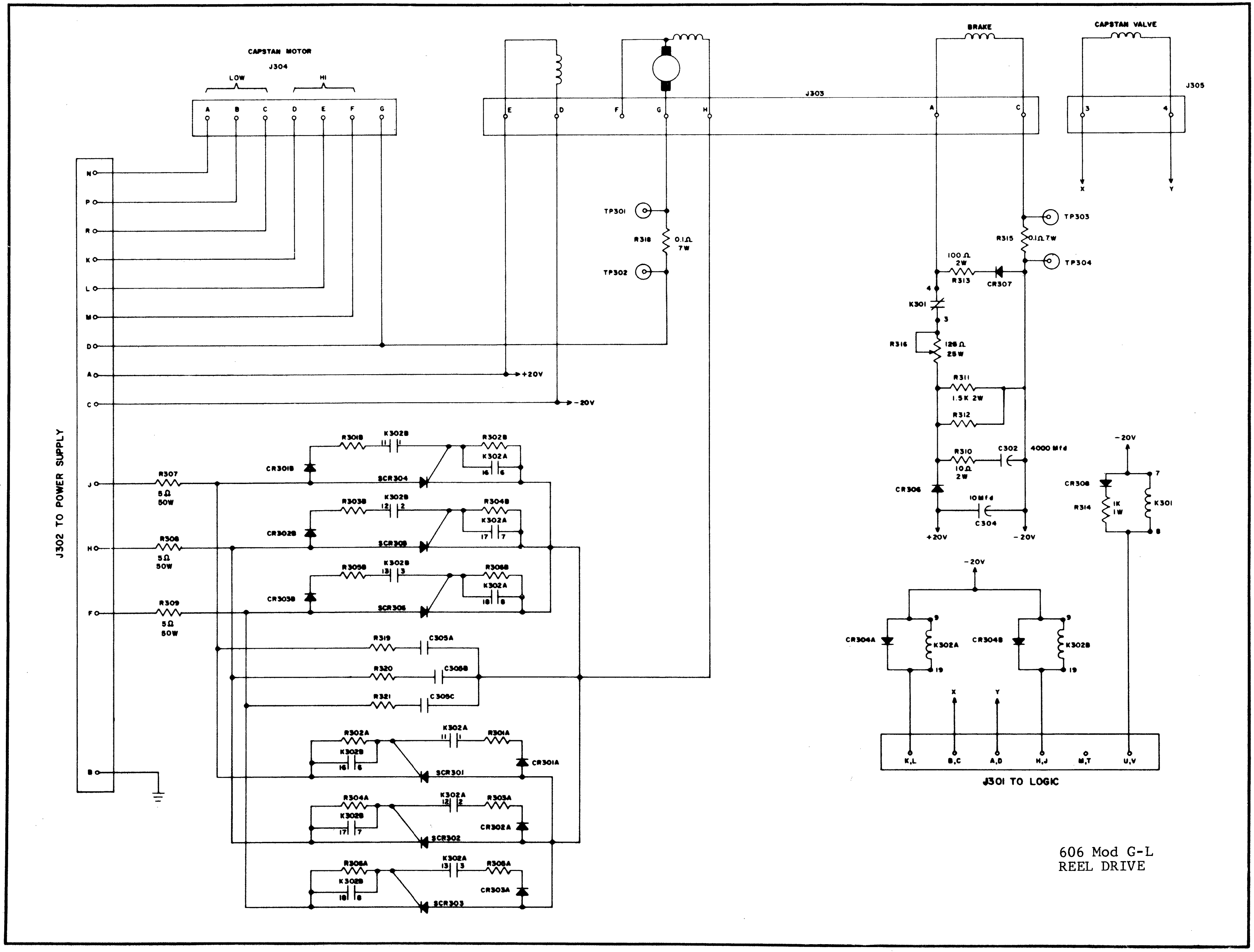


606 Mod G-L
CARD PLACEMENT

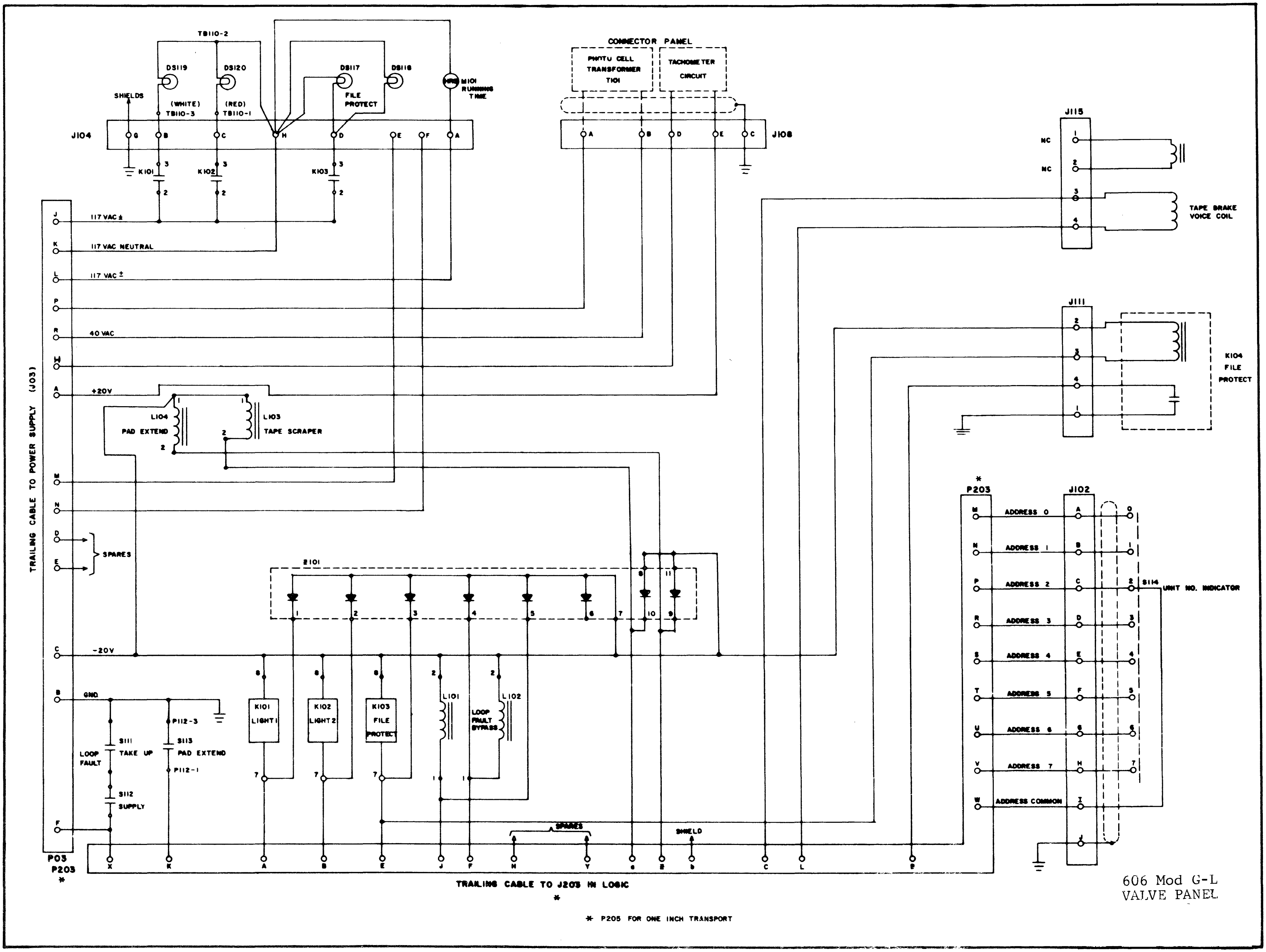


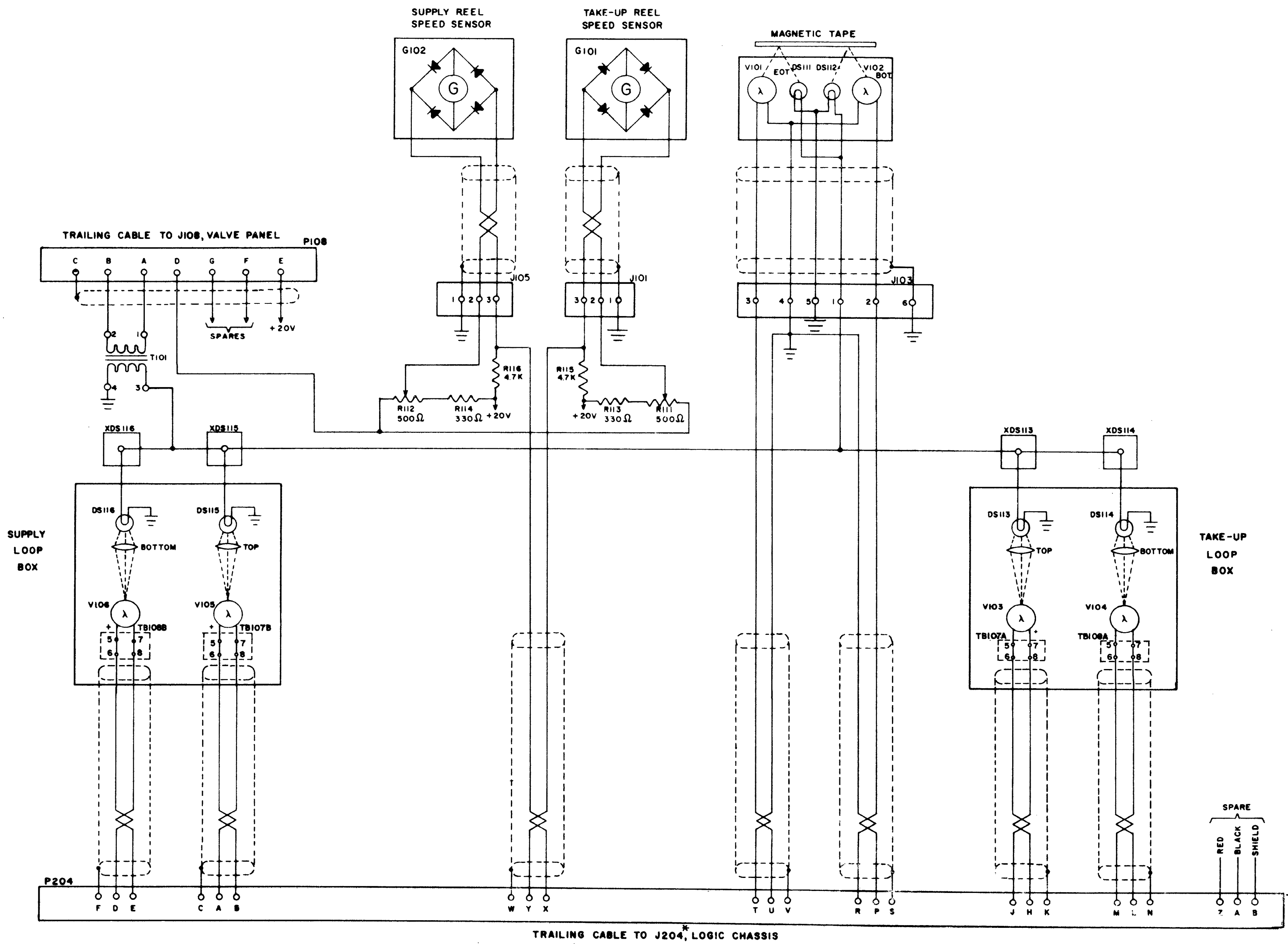
NOTES:
△ INDICATES TRAILING CABLE

606 Mods G-1
CABLING DIAGRAM



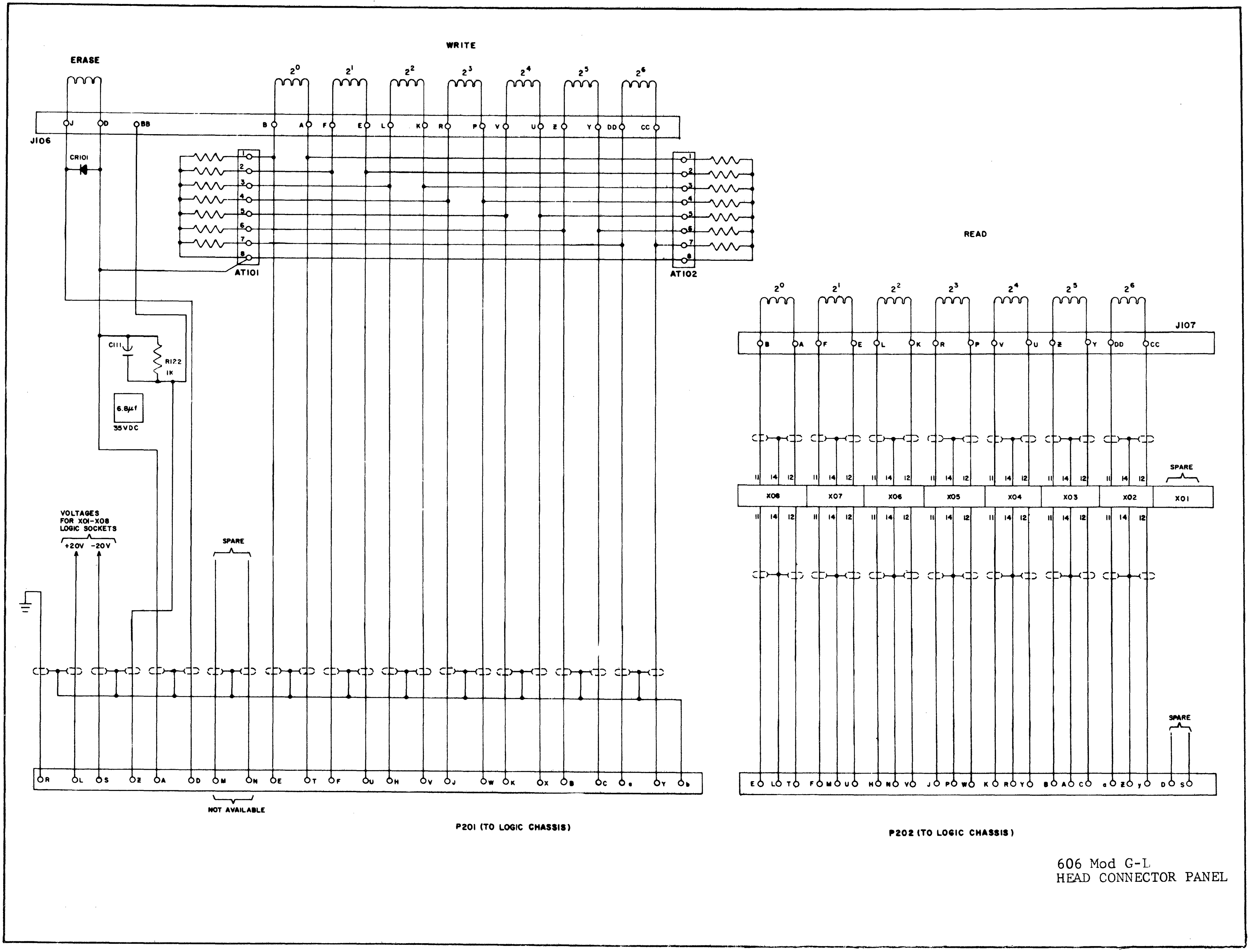
606 Mod G-L
REEL DRIVE


TB110-2
DS119
DS120
DS117
DS118
M101 RUNNING TIME
SHIELDS
(WHITE) TB110-3
(RED) TB110-1
FILE PROTECT
J104
K101
K102
K103
CONNECTOR PANEL
PHOTO CELL TRANSFORMER T101
TACHOMETER CIRCUIT
J108
J115
NC
NC
TAPE BRAKE VOICE COIL
J111
K104 FILE PROTECT
117 VAC ±
117 VAC NEUTRAL
117 VAC ±
40 VAC
+20V
L104 PAD EXTEND
L103 TAPE SCRAPER
TRAILING CABLE TO POWER SUPPLY (J03)
SPARES
Z101
-20V
GND
K101 LIGHT 1
K102 LIGHT 2
K103 FILE PROTECT
L101
L102
LOOP FAULT BYPASS
S111 TAKE UP
LOOP FAULT
S112 SUPPLY
P112-3
S113 PAD EXTEND
P112-1
P03
P203
*
P203
J102
ADDRESS 0
ADDRESS 1
ADDRESS 2
ADDRESS 3
ADDRESS 4
ADDRESS 5
ADDRESS 6
ADDRESS 7
ADDRESS COMMON
S114 UNIT NO. INDICATOR
SPARES
SHIELD
TRAILING CABLE TO J203 IN LOGIC
*
* P205 FOR ONE INCH TRANSPORT
606 Mod G-L
VALVE PANEL



606 Mod G-L
CONNECTOR PANEL

* J206 FOR ONE INCH TRANSPORTS



606 Mod G-L
HEAD CONNECTOR PANEL

APPENDIX A

STUDY PROBLEM ANSWERS

APPENDIX A

STUDY PROBLEM ANSWERS

SECTION II STUDY QUESTION ANSWERS

1. d
2. c
3. b
4. b
5. d
6. c
7. c
8. c
9. d
10. c
11. d
12. d
13. d
14. d
15. 0101010 CSSSSSS
    1011110 SSCCCCS
    1001100 CSCSSCS
    0101101 CCCCCCC
16. d
17. c
18. b
19. d
20. d
21. a
22. e
23. c
24. b
25. c
26. d
27. c
28. c
29. c
30. c
31. d
32. c
33. c
34. c
35. b
36. a
37. b
38. d
39. b
40. c
41. a
42. b
43. b
44. d
45. b
46. d
47. c
48. a
49. b
50. d
51. a
52. a
53. d
54. d
55. c
56. c
57. d
58. d
59. a
60. d
61. d
62. a
63. d

APPENDIX B

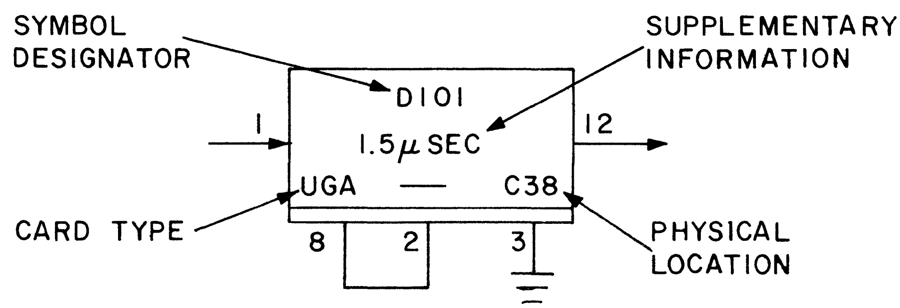
SPECIAL MODULES

SPECIAL MODULES

LOGIC SYMBOLS

All special modules (including delays*) are represented by rectangles. Inputs are shown with arrows normally from the left, and outputs normally extend out to the right. Other connections to the card such as jumpers and grounds, except disabled OR inputs, are shown without arrowheads. The double bar on one or more sides of the symbol is used to indicate a non-logic voltage level.

EXAMPLE:



*Passive delays such as capacitors mounted on a card are represented by an oval symbol.

CARD TYPE DESIGNATION

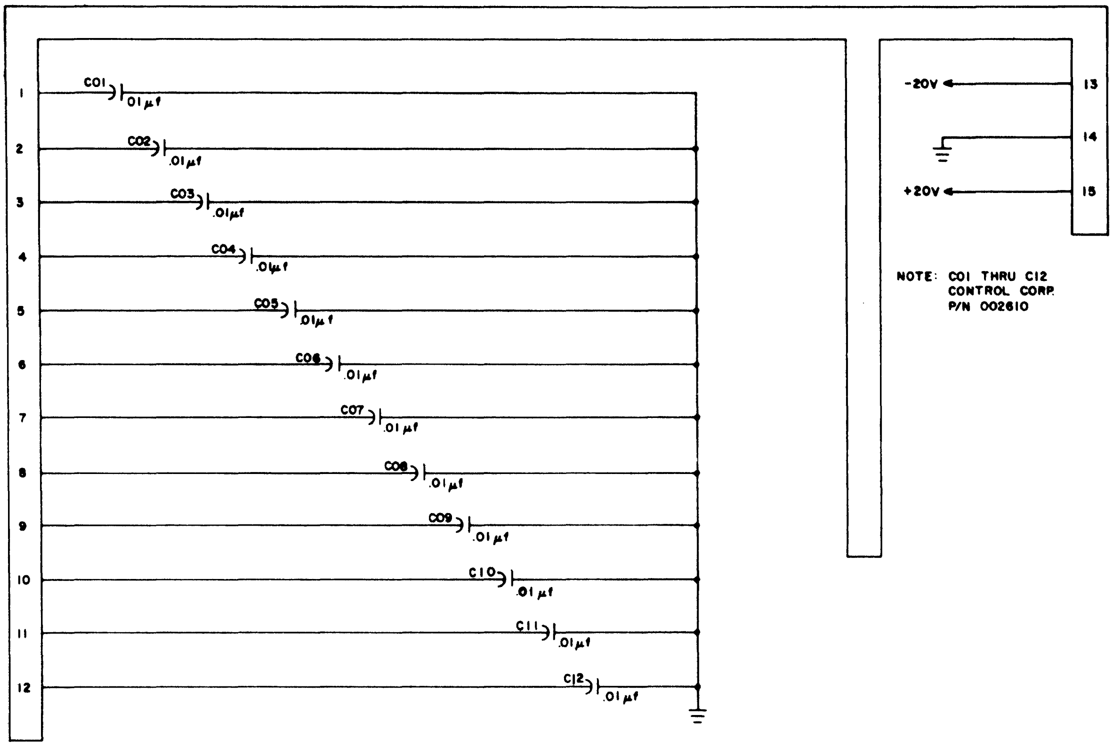
Five general categories are used for classifying special purpose circuits for peripheral equipment:

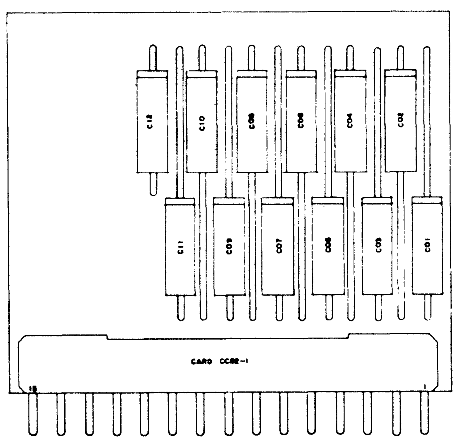
1. A-D (AA-, AB-, ... DY-, DZ-)
2. E-H (EA-, EB-, ... HY-, HZ-)
3. I-N (IA-, IB-, ... NY-, NZ-)
4. O-T (OA-, OB-, ... TY-, TZ-)
5. U-Z (UA-, UB-, ... ZY-, ZZ-)

The two most significant letters (IA-, for example) define the basic circuit. The least signficant letter defines slight variations with the possibility of interchange in some but not all applications. Standard power supply connections are -20v on pin 13, ground on pin 14, +20v on pin 15, and no low impedance voltage sources on other pins. Standard voltage levels on input and output are -0.5v and -3v and match internal logic of standard cards such as flip-flops and inverters (including the 10, 20, and 30 series). Nonstandard input (or output) signals indicate one or more inputs (or outputs) that may be analog or digital, but cannot generally interface with standard cards such as flip-flops and inverters.

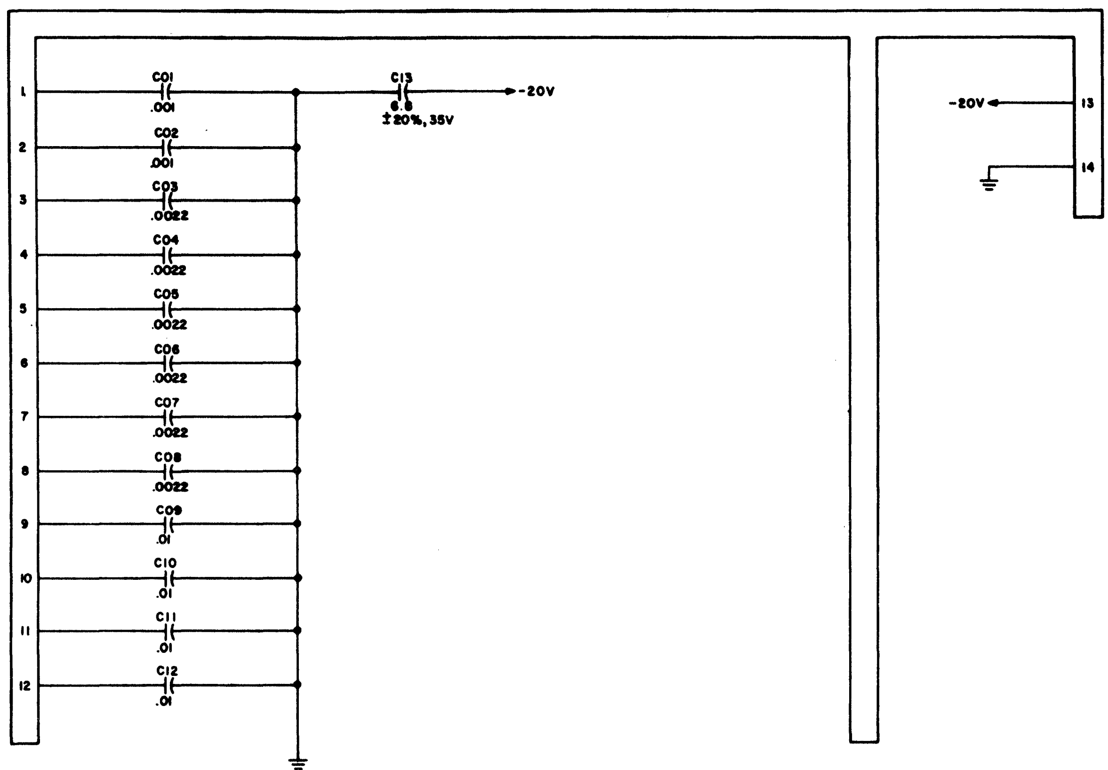
Category	Designation	Power Supply	Input	Output
A	AAA to DZZ	Nonstandard	Standard or Nonstandard	Standard or Nonstandard
E	EAA to HZZ	Standard	Nonstandard	Nonstandard
I	IAA to NZZ	Standard	Standard	Nonstandard
O	OAA to TZZ	Standard	Nonstandard	Standard
U	UAA to ZZZ	Standard	Standard	Standard

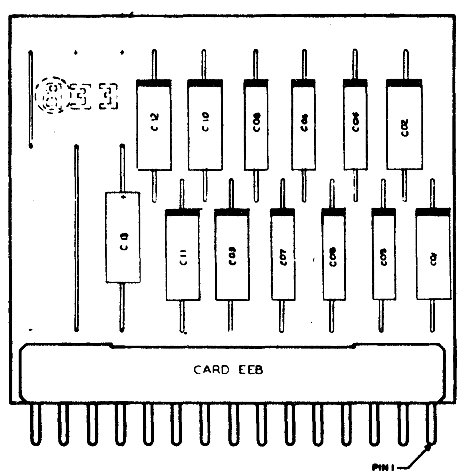
CAPACITOR
CC82-1



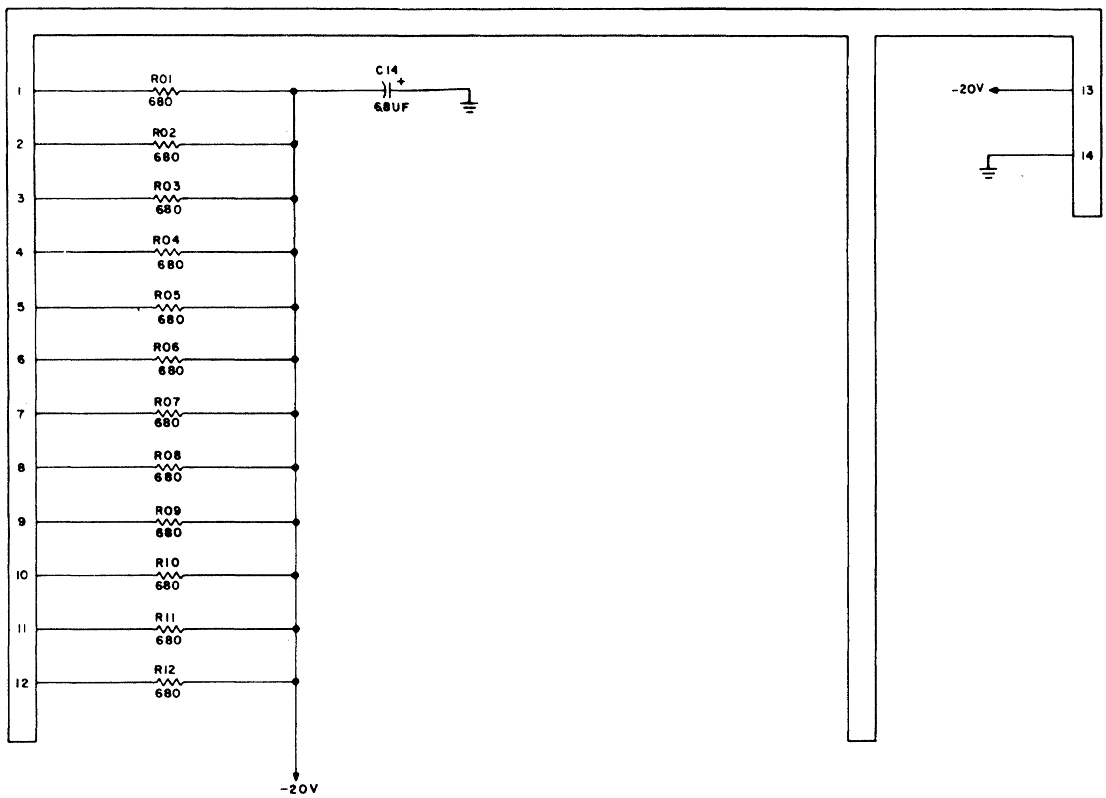


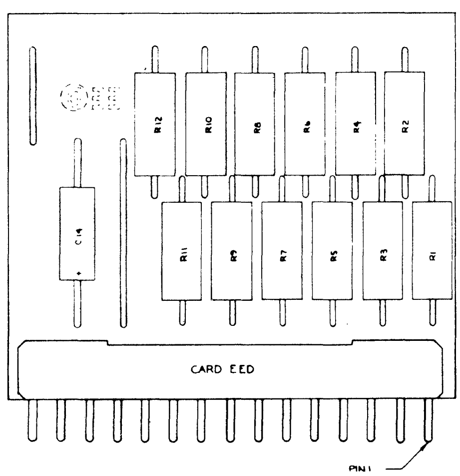
CAPACITOR TERMINATION
EEB





RESISTOR TERMINATION
EED





READ PREAMPLIFIER

EHA, EHB, EHC

The read preamplifier is used in the read data circuit to amplify NRZ1 information recorded on magnetic tape for use in subsequent level and peak detecting circuits. The amplifier circuit includes provision for a differential input and a balanced push-pull output.

The preamplifier has two differential stages of gain (Q01, 02, and Q05, 06) to minimize common mode signal interference. Each differential stage includes an isolating emitter follower output (Q03,04,07,08) to reduce loading effects on the inverting amplifier.

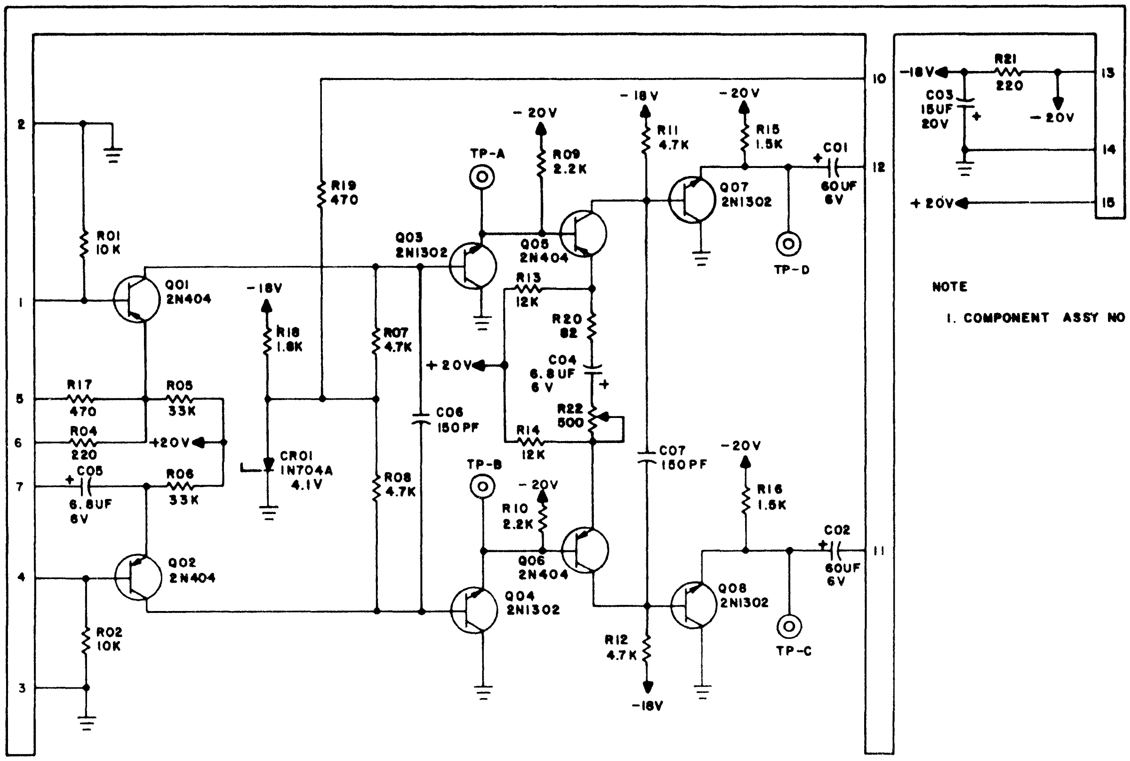
Coarse and fine gain adjustments are provided by negative feedback in the emitter of each stage of gain. Two steps of coarse gain may be selected in the first stage by external jumpers. Connecting pin 5 to pin 7 provides minimum gain and connecting pin 5 to pin 8 provides maximum gain. Fine gain is provided by adjusting the potentiometer R22 in the second stage. This adjustment provides the following gains:

		Jumper Pins
EHA -	150 to 550	5-7
	350 to 1300	5-8
EHB -	200 to 800	5-7
	500 to 1800	5-8

Except for the output and the emitter degeneration, the amplifier is direct-coupled to reduce recovery time. Power supply transients are minimized by the common mode rejection of the differential amplifier. In addition, R21 and C03 filter the negative supply for both stages; CR01 and R18 reduce the voltage for the first stage.

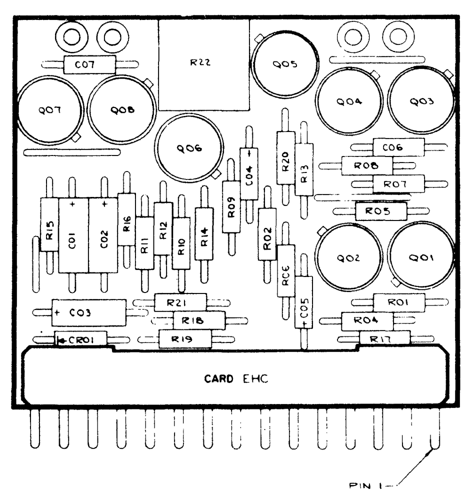
The EHC circuit differs from the EHB as follows:

1. Capacitors C06 and C07 provide two stages of high frequency roll-off. Each capacitor reduces gain by about 3 db at 100 kc (sine wave).
2. Output capacitors C01 and C02 are polarized for load terminations of -10 to -16 volts or for isolated transformer windings such as those on EI-series cards.
3. Gain jumpering options are not interchangeable with the EHB except when pin 5-7 is used at frequencies of 30 kc and lower. Gain ranges for sine-wave frequencies of 5 to 30 kc are



NOTE

1. COMPONENT ASSY NO 50008601.



EHC

READ LEVEL DETECTOR
EIA, EIB, EID, EIE

The read level detector receives the amplifed signal from the read preamplifier (EH-series) and provides a rectified signal and a threshold enable for the peak detector (OG-series) in the recovery of NRZ1 information from the magnetic tape.

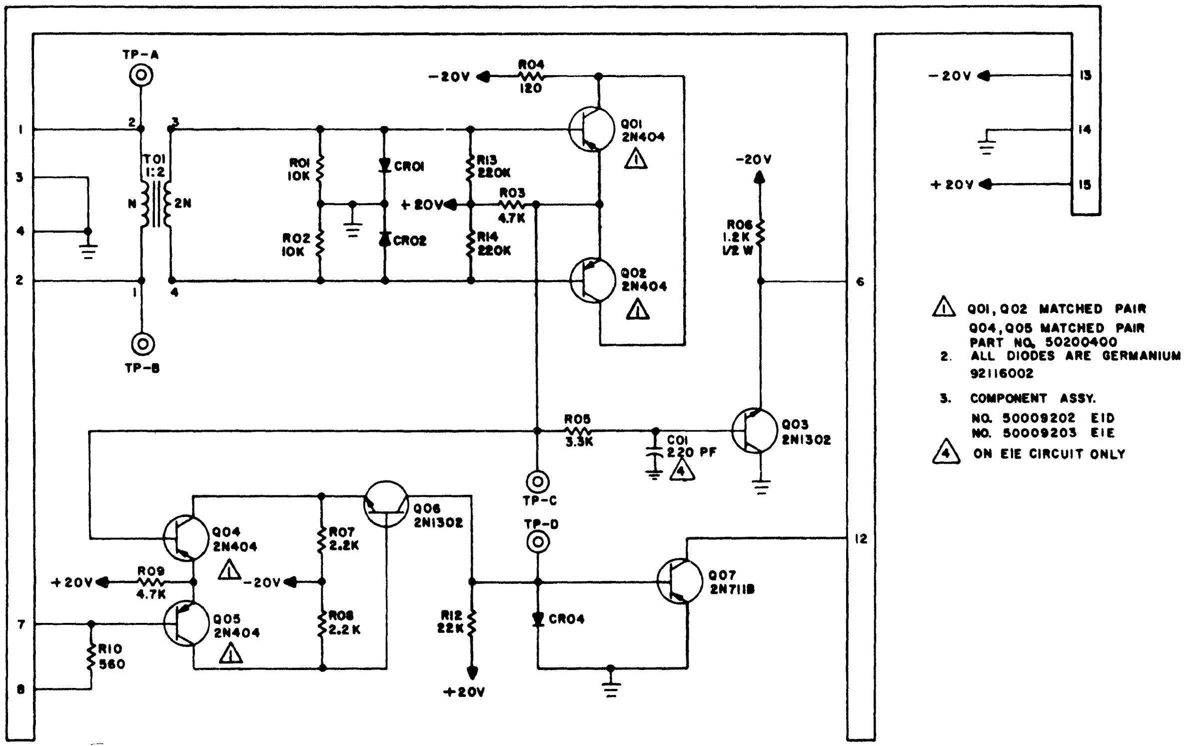
The rectifying circuit is composed of transformer T01, diodes CR01 and CR02, and transistors Q01 and Q02. The negative rectified signal is then routed to the differential input stage of the level detecting circuit (Q04 and Q05). The signal is compared to the threshold input reference voltage on pin 7. The switching point is further enhanced and referenced to ground by the amplifiers consisting of transistors Q06 and Q07, in a form usable as an enable in the peak detector.

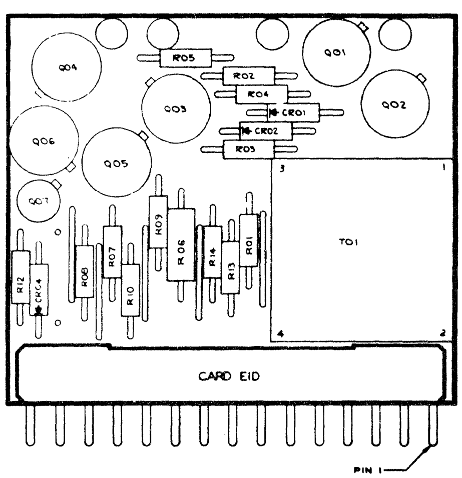
The rectified signal is also routed to an output emitter follower (Q03) which drives the RC differentiating circuit in the input stage of the peak detector.

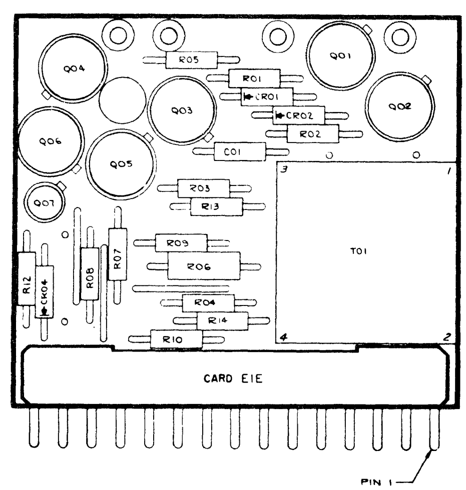
The EID and EIE circuits differ from the EIB as follows:

1. Rectifier transformer T01 is designed to pass 5 kc sine-wave signals compared to 20 kc as a lower limit on the EIB card. This delays and filters some of the higher frequency components and is intended primarily for fundamental signals not exceeding 45 kc sine-wave frequency (90 kc NRZ1 data rate).
2. Resistors R13 and R14 are added to cause diodes CR01 and CR02 to maintain a lower transformer secondary impedance during zero or weak signals.
3. Q01 and Q02 are matched transistors to assure better signal balance of both polarities of input. Transistors Q04 and Q05 are matched to provide more accurate level detection thresholds.

The EIE card differs from the EID only in the addition of C01, which provides one RC stage of additional high frequency roll-off (down 3 db at 200 kc data rate).


TP-A
TP-B
TP-C
TP-D
T01
1:2
N
2N
-20V
R04
120
Q01
2N404
Q02
2N404
R01
10K
R02
10K
CR01
CR02
R13
220K
R14
220K
+20V
R03
4.7K
R06
1.2K
1/2 W
R05
3.3K
C01
220 PF
Q03
2N1302
Q04
2N404
Q05
2N404
Q06
2N1302
R07
2.2K
R08
2.2K
R09
4.7K
R10
560
R12
22K
CR04
Q07
2N711B
Q01, Q02 MATCHED PAIR
Q04, Q05 MATCHED PAIR
PART NO. 50200400
2. ALL DIODES ARE GERMANIUM
92116002
3. COMPONENT ASSY.
NO. 50009202 EID
NO. 50009203 EIE
ON EIE CIRCUIT ONLY


CARD EID
PIN 1


CARD EIE
PIN 1

EIE

RELAY PULLER

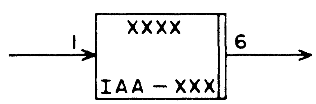
IAA, IAB

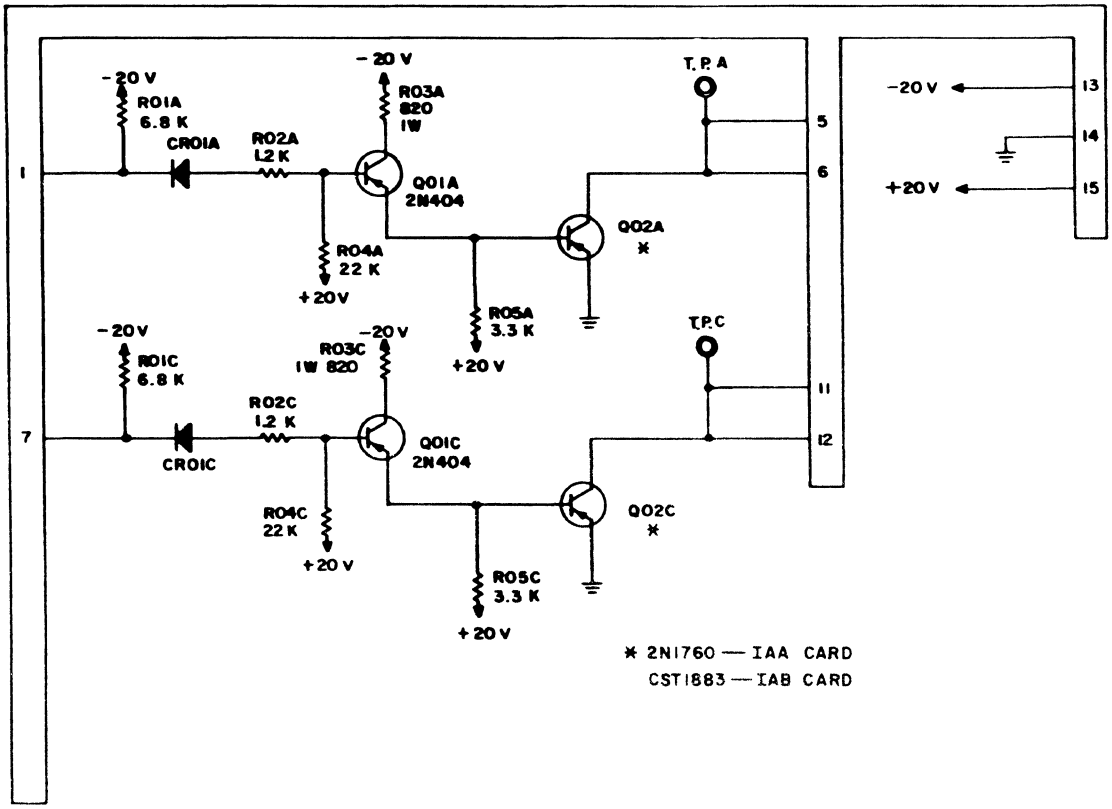
This circuit is used to drive inductive loads such as relays and solenoids and loads with high current surges such as incandescent lamps and the discharge of capacitors. It is particularly useful in driving loads up to 0.6 amp which are terminated at negative voltages from -5v to -36v. IAB cards drive loads to 0.4 amp.

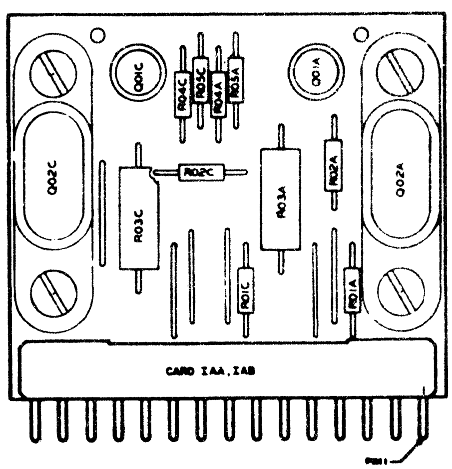
The relay puller circuit can also be used as a slow L---card. The input-output voltage levels are the same for both cards.

The input stage of the relay puller circuit has its transistor connected as an emitter follower with the collector returned to -20v through a limiting resistor R03. The first stage emitter follower current does not flow through the load as it does in circuits such as the 55 card. The only current flowing to the load in the turnoff condition is the leakage current of the output transistor. The circuit limits collector voltage on Q01 to -20v; Q02 may have excursions to -36v. Turnon time is 5 usec maximum and turnoff switching is 25 usec maximum.

SYMBOL




-20 V
R01A
6.8 K
CR01A
R02A
1.2 K
-20 V
R03A
820
1W
Q01A
2N404
T.P. A
5
6
Q02A
*
R04A
22 K
+20 V
R05A
3.3 K
+20 V
-20 V
13
14
+20 V
15
1
-20 V
R01C
6.8 K
R03C
1W 820
-20 V
T.P. C
11
12
R02C
1.2 K
7
CR01C
Q01C
2N404
Q02C
*
R04C
22 K
+20 V
R05C
3.3 K
+20 V
* 2N1760 — IAA CARD
CST1883 — IAB CARD


Q01C
R04C
R05C
R04A
R03A
Q01A
Q02C
R02C
R03A
R02A
Q02A
R03C
R01C
R01A
CARD IAA, IAB

IAA, IAB

POWER EMITTER FOLLOWER

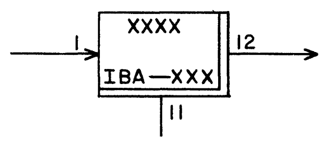
IBA

This circuit, used with a solid-state H switch (capstan drive circuit), drives diagonally opposite legs of the switch. A separate card of this type drives a switching transistor which provides a 2-msec double-magnitude current pulse to reduce actuation time.

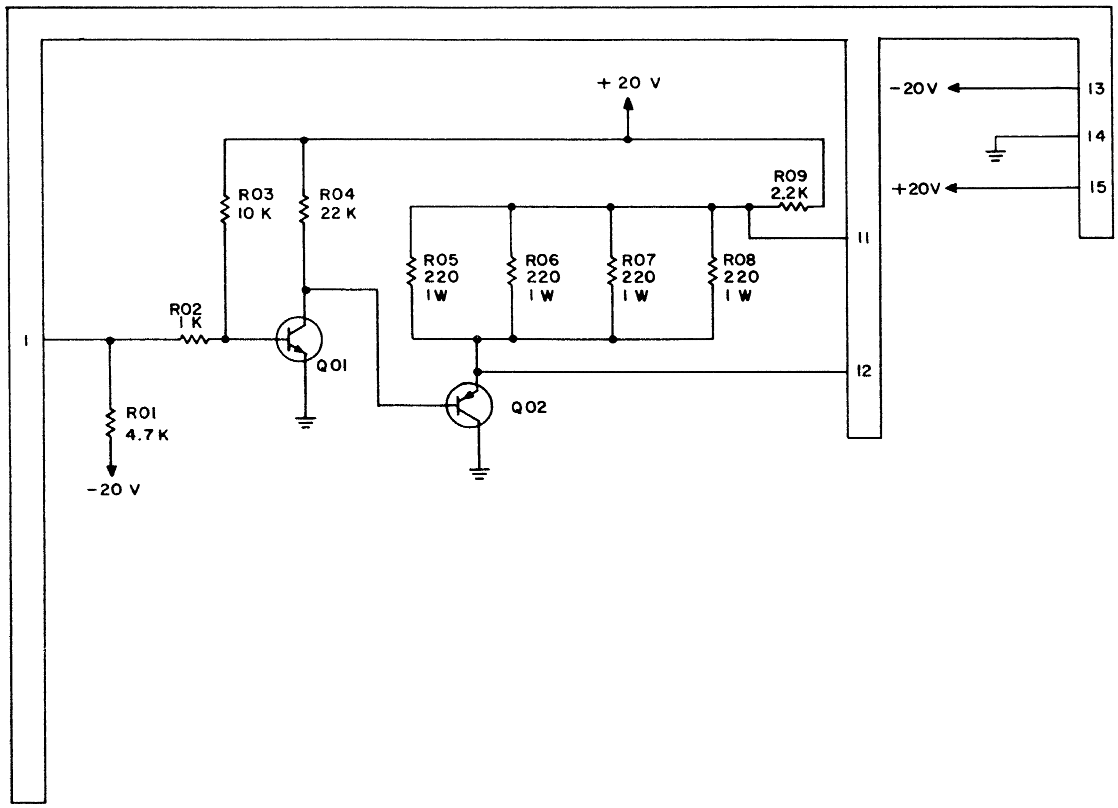
The circuit differs from the regular inverter circuit in that the output load is returned to +20v instead of -20v.

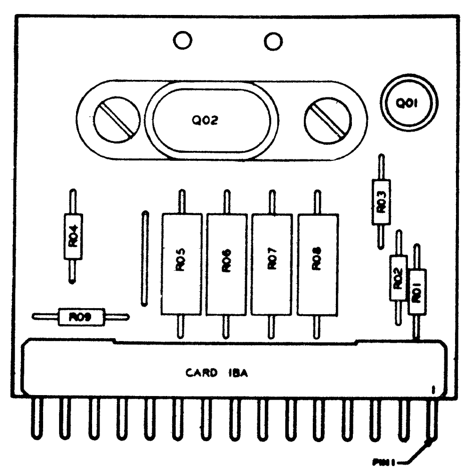
Turnon time varies from 1 to 20 usec with the current limiting resistor output connected to +20v. Turnoff switching ranges from 5 to 50 usec. Loads on pins 11 and 12 should require a total of 0.6 amp or less and be terminated to -12v or less.

SYMBOL



3-IBA-1


+ 20 V
- 20V
13
14
+20V
15
R09
2.2K
R03
10 K
R04
22 K
R05
220
1 W
R06
220
1 W
R07
220
1 W
R08
220
1 W
11
R02
1 K
1
Q01
12
Q02
R01
4.7 K
-20 V


Q02
Q01
R03
R04
R05
R06
R07
R08
R02
R01
R09
CARD IBA
PIN 1

3-IBA-2

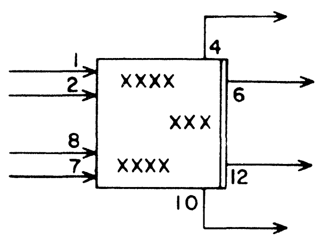
FLIP-FLOP WRITE DRIVER
IJA

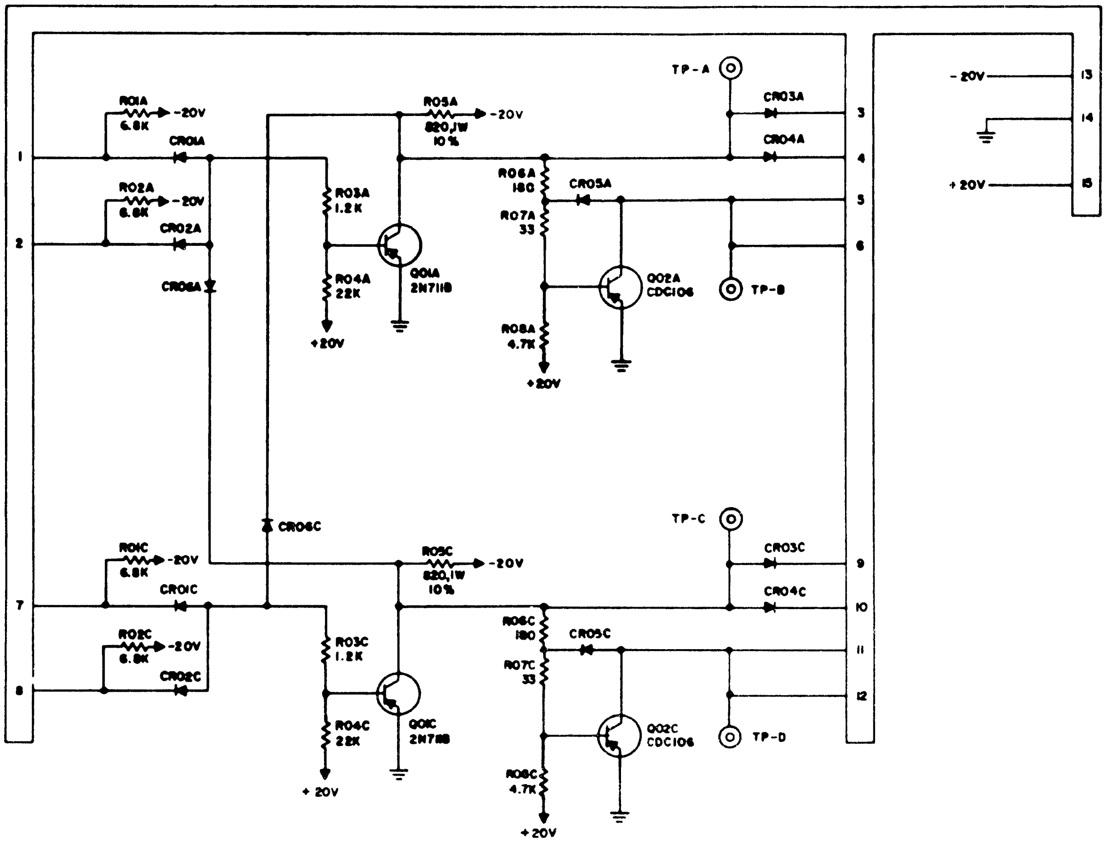
A flip-flop and write driver circuit are combined on one card (refer to IIA write driver discussion).

The circuit consists of two transistors (Q01A and Q01C) connected as a flip-flop, each with two OR inputs (diodes CR01 and CR02). Each side of the flip-flop is provided with two AND outputs (diodes CR03 and CR04). The remainder of the flip-flop output is used to drive transistors Q02A and Q02C, which supply up to 160 ma output load.

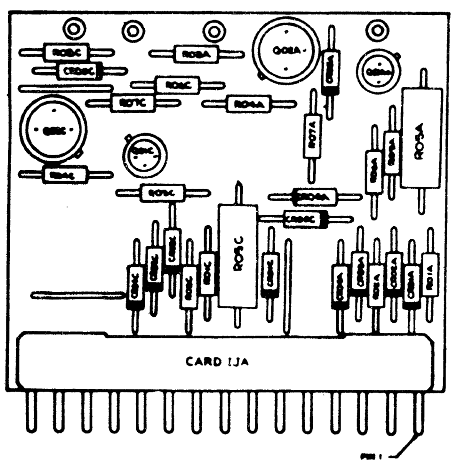
Because of the double inversion in this circuit, continuous "1" inputs to both sides of the flip-flop turn off both Q02A and Q02C to shut off write current.

SYMBOL





R01A
6.8K
-20V
CR01A
R02A
6.8K
CR02A
CR06A
R03A
1.2K
R04A
22K
+20V
Q01A
2N1118
R05A
820,1W
10%
R06A
180
R07A
33
CR05A
Q02A
CDC106
R08A
4.7K
TP-A
TP-B
CR03A
CR04A
+20V
CR06C
R01C
6.8K
CR01C
R02C
6.8K
CR02C
R03C
1.2K
R04C
22K
Q01C
2N1118
R05C
820,1W
10%
R06C
180
R07C
33
CR05C
Q02C
CDC106
R08C
4.7K
TP-C
TP-D
CR03C
CR04C



CARD IJA
R05A
R05C

IJA

PHOTOCELL AMPLIFIER

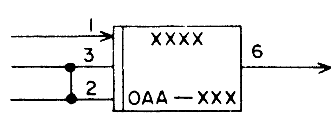
OAA

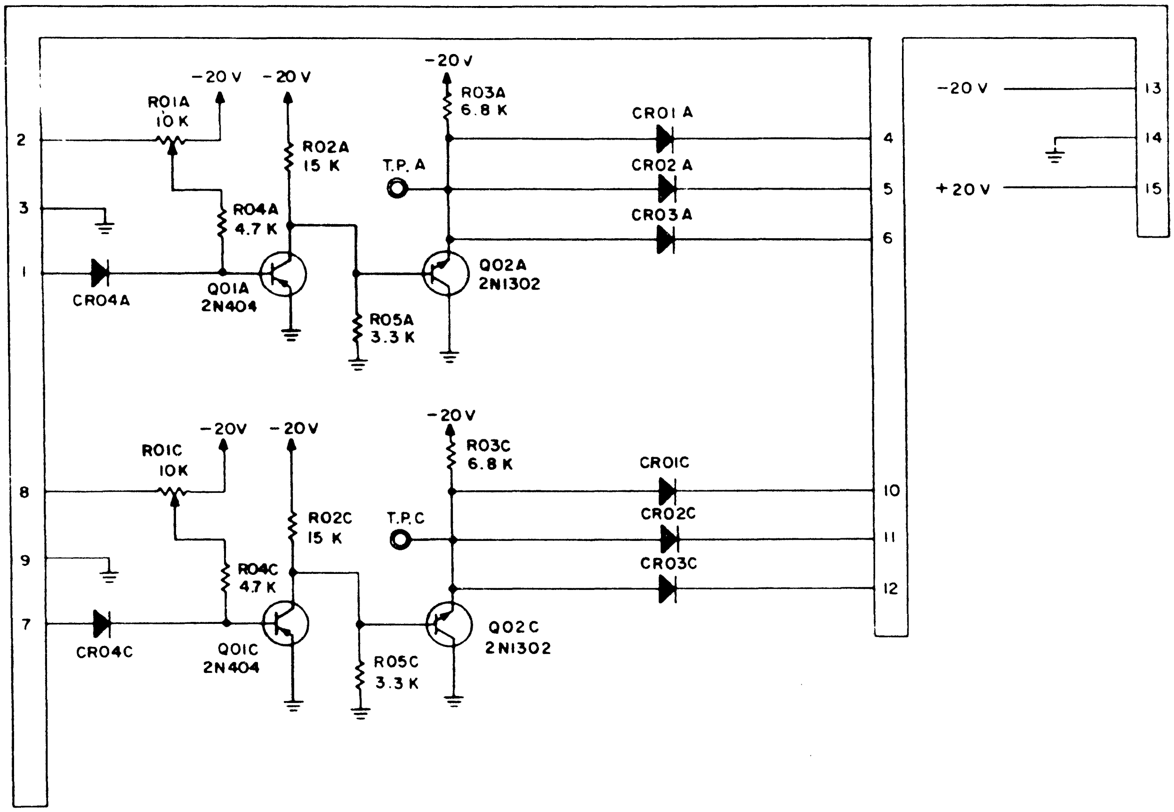
The photocell amplifier receives inputs from silicon solar cells. The output from the amplifier is a "1" when the solar cell is illuminated and a "0" when unlighted. An adjustable potentiometer is provided because of low level signals normally available from the solar cells. This allows optimum centering of the switching point of the amplifier to compensate for the overall photocell excitation, sensitivity, and amplifier tolerances.

The first stage of the amplifier consists of an inverting amplifier Q01. This transistor is turned on by drive current flowing through R04 from potentiometer R01. Normally pin 2 is jumpered externally to pin 3 to provide R01 with the maximum range of adjustment. The positive terminal of the photocell counteracts the turnon current of R04. Sufficient output from the photocell turns off Q01. CR04 compensates for the change in base to emitter potential of Q01 with changing temperature.

The output of Q01 is directly coupled to Q02 which acts as an emitter follower. The logical "1" excursion at the output is determined primarily by the divider composed of R02 and R05 since the gain of Q02 is sufficient to provide only minor loading of this resistance regardless of the number of outputs actually used. Three diodes (CR01, 02, 03) are provided for ANDing with other logical circuits.

SYMBOL




-20 V
R01A
10 K
R02A
15 K
R04A
4.7 K
Q01A
2N404
CR04A
R05A
3.3 K
R03A
6.8 K
T.P. A
Q02A
2N1302
CR01 A
CR02 A
CR03 A
R01C
10K
R02C
15 K
R04C
4.7 K
Q01C
2N404
CR04C
R05C
3.3 K
R03C
6.8 K
T.P.C
Q02C
2N1302
CR01C
CR02C
CR03C
+20 V
1
2
3
4
5
6
7
8
9
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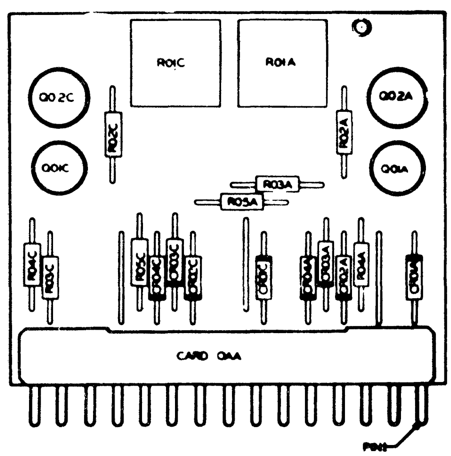
11
12
13
14
15


R01C
R01A
Q02C
Q02A
Q01C
Q01A
R02C
R02A
R03A
R05A
CARD OAA

OAA

PEAK DETECTOR

OGA, OGB, OGC

The peak detector operates from either positive or negative rectified signals from the output of level detectors. The peak detector can also be used with class A signals to locate either positive or negative peaks as selected by the input wiring. Provision is included for threshold enabling prior to the output when used with level detector (EI-Series) or "diode ANDing" at the output of level detector (EDA, EGA). The output of the peak detector is shaped to a nominal 3/4-usec pulse independent of the exact shape of the peak.

Peak detection is accomplished by first differentiating the input signal (C01, R01 and C04, R02) and then detecting the zero crossover point of this differentiated signal in the two-stage differential amplifier (Q01, Q02, and Q03, Q04). The detected zero crossover point is re-referenced to ground by Q05 and then shaped by the multivibrator (Q06, Q07) into a nominal 3/4-usec "1" pulse. Pin 8 receives the threshold enable signal, when used with the level detector to disable the output shaper. Other threshold enables (level detector EDA, EGA) are ANDed with pins 11 and 12. Mixing resistors are provided at pins 9 and 10 for use in forming composite signals with peak detectors on other tracks for deskewing purposes.

Pin 1* is used to receive positive rectified signals (pin 5** grounded); and pin 5** is used to receive negative rectified signals (pin 1* grounded). Therefore, the peak detector looks for a negative peak on pin 5** or a positive peak on pin 1*. Balanced or single-ended class A signals may be used also, and the input wiring determines which polarity peak is detected.

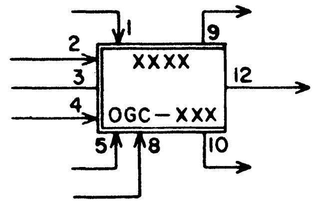
The multivibrator is triggered by the negative input signal at the base of Q06. Conduction of Q06 couples a positive pulse to the base of Q07 and causes it to switch off. Multivibrator regeneration is completed by the common emitter resistor R13. The period of the mutivibrator is determined by C07 and R14. Recycle time is determined by R15, R16, and C07. Diode CR03 supplies the additional emitter current necessary for the collector load of Q07 and references the emitter current to near ground for this stable state of the multivibrator. During the multivibrator period

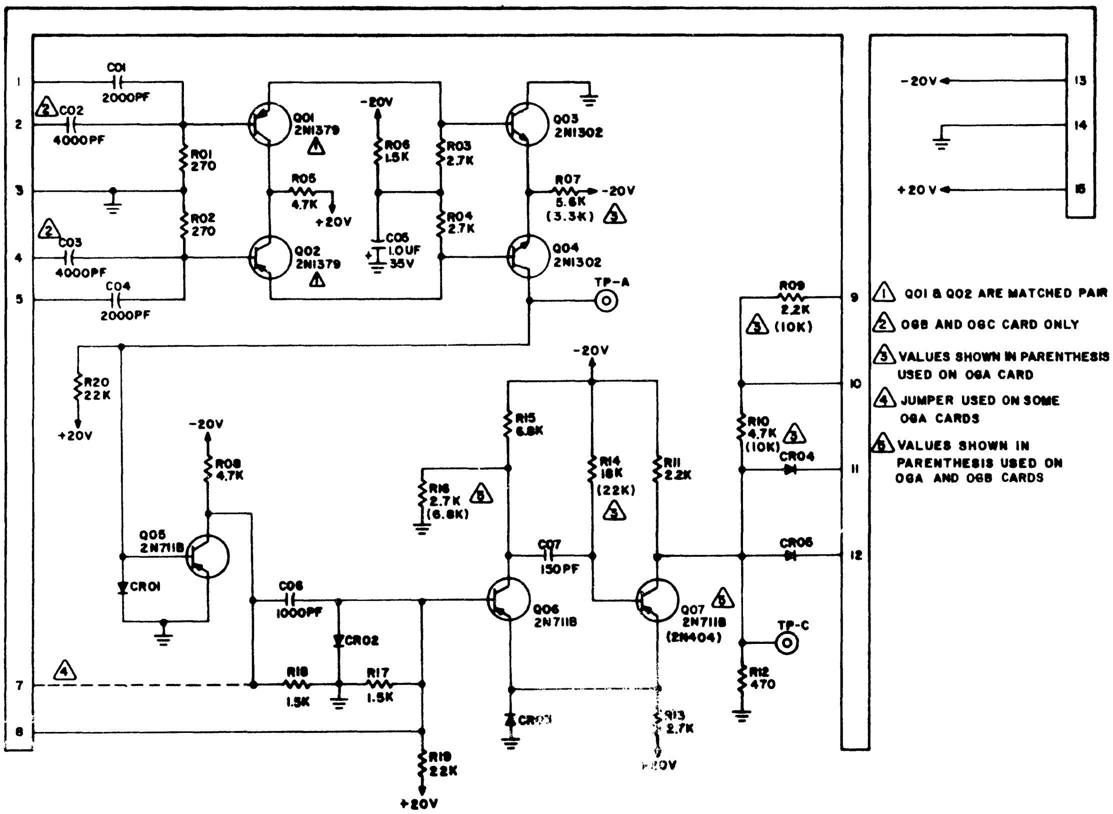
* Pin 2 for 75 ips, OGB, OGC only

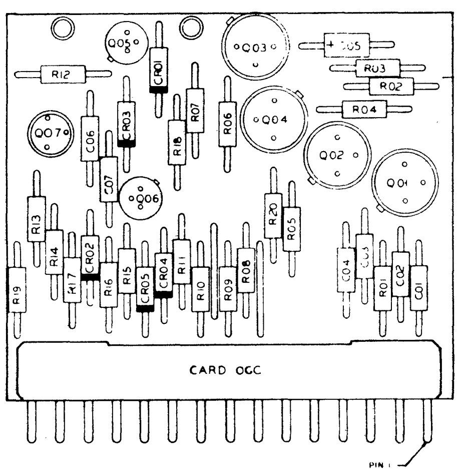
** Pin 4 for 75 ips, OGB, OGC only

CR03 is reverse-biased, permitting the gain of Q06 and Q07 to be utilized through a common emitter resistance R13, providing fast fall and rise times.

SYMBOL







OGC

ADJUSTABLE DELAY

UAA, UAB

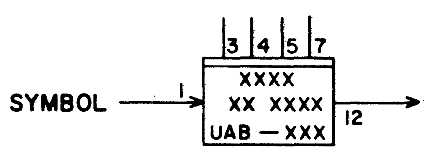
The adjustable delay circuit is noninverting in relation to the input but changes from "1" to "0" are delayed at the output.

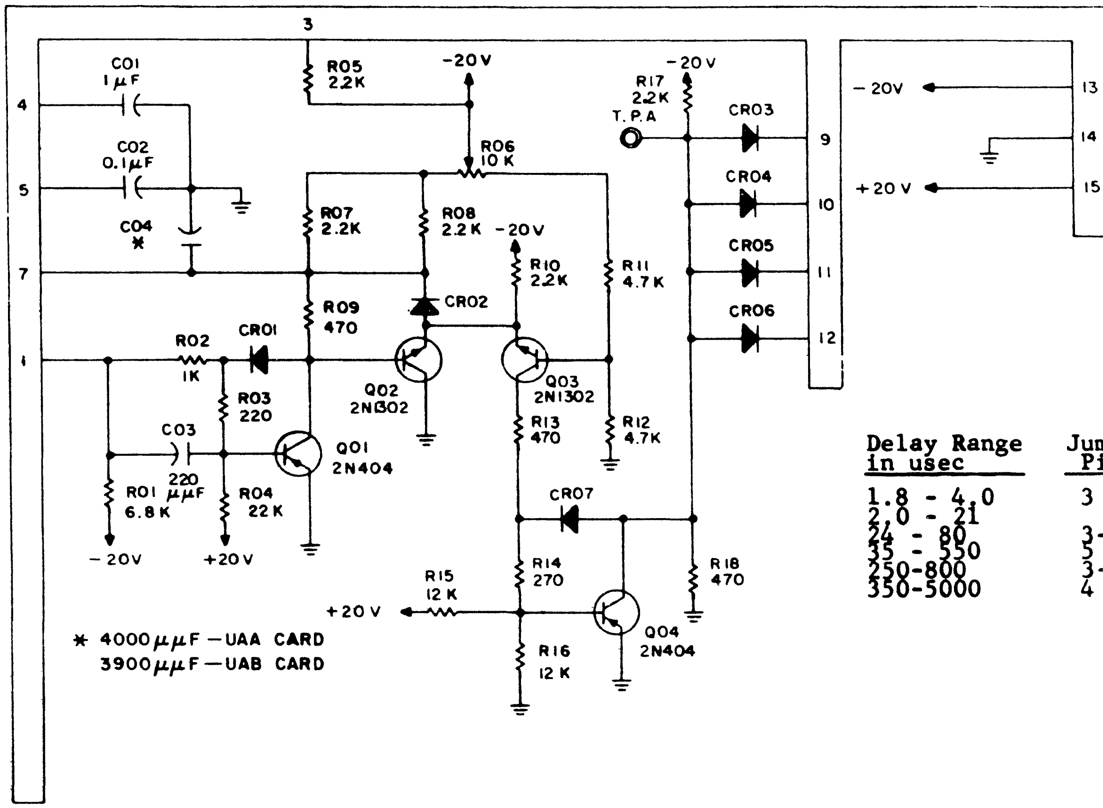
The input stage of the circuit is an inverting circuit with a speed-up diode (CR01) to reduce turnoff time in Q01. The timing circuit is composed of C04, R07, R08, and potentiometer R06. Longer range delays are obtained by paralleling C04 with C01 and/or C02 with external jumpers. A limited delay adjustment may be obtained by paralleling R05 with the charge network (R07, R08, and R06). Some external adjustment may also be obtained by connecting a potentiometer between pins 3 and 7. The UAB card has a temperature stable capacitor, C04, for delays below 25 usec.

Discharge of C04, which recycles the delay, is accomplished by the emitter follower (Q02) in the second stage through diode CR02. Drive to Q02 is determined by the drop across R09 which also provides a small percentage of the current to discharge C04. To provide 98% of the full delay period, a recycle time of 1 usec is required when using C04 alone, 2 usec when C02 is added, and 10 usec when C01 is added.

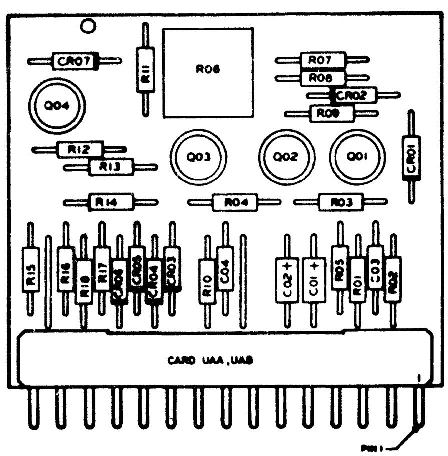
The third stage is emitter driven to obtain voltage gain and proper bias reference to switch the output stage. The base circuit reference is changed by connecting R06 as a voltage divider. As R06 inserts resistance to increase the RC time constant, it also removes resistance in the base divider of Q03. A greater portion of the RC time constant can be used for long delays. The normal adjustment range of 9 to 1 is extended to approximately 20 to 1.

The fourth and final stage, Q04, is an inverter circuit with a saturation limiting diode (CR07) which limits base drive. A divider circuit in the base allows considerable voltage swing to improve turnon time. The output excursions are limited in the negative direction by a resistance divider.





Delay Range in usec	Jumper Pin
1.8 - 4.0	3 - 7
2.0 - 21	-
24 - 80	3-5-7
35 - 550	5 - 7
250-800	3-4-7
350-5000	4 - 7



UAB

ADJUSTABLE PULSE DELAY

UCB

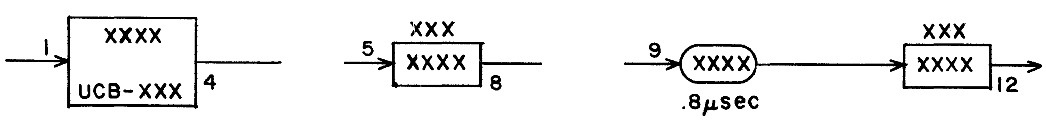
The pulse delay card is used as a read and write skew adjustment which compensates for mechanical misalignment of head gaps and small switching delays or phase lags in the electronic amplifiers. The card produces a narrow output pulse after a short adjustable delay (1 3/4 - 5 usec). A recycle time of 5 usec is necessary for delays to equal 95% of the specified delay period.

The circuit is divided into three sections. Circuit A is a one-shot multivibrator circuit composed of transistors Q01A and Q02A. The multivibrator is triggered by a negative input signal passing through a differentiating network to the base of Q01A. Conduction of Q01A couples a positive pulse to the base of Q02A and causes it to switch off. Multivibrator regeneration is completed by the common emitter resistor R11A. The period of the multivibrator is determined by R08A, C02A, and the resistance of potentiometer R10A. Recycle time is determined by resistors R06A and R07A and capacitor C02A. Transistor Q02A is a high-gain transistor which provides reserve output current for the limited base drive available in the circuit. Diode CR05A supplies the additional emitter current necessary for the collector load of Q02A, and references the emitter to near ground for this stable state of the multivibrator. During the multivibrator period, CR05A is reverse biased, permitting the gain of the two transistors to be utilized through a common emitter resistance (R11A) providing fast fall and rise times.

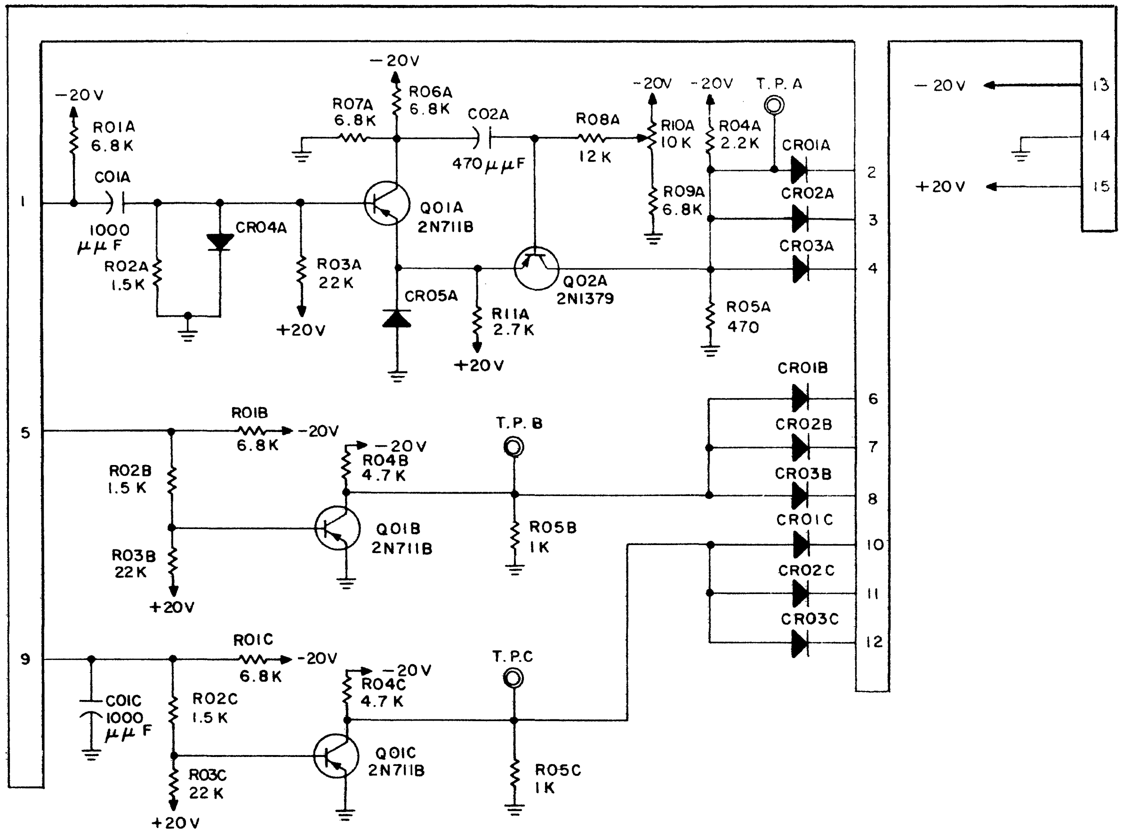
Circuits B and C are simplified inverter circuits which use a high-frequency transistor to decrease switching time. Circuit C also uses a delay capacitor C01C which allows the positive output to be delayed permitting ANDing with the output of circuit B for a 3/4-usec pulse output.

The three circuits are not connected internally and may be used as separate and complete elements. The circuits may also be connected through external jumpers to provide a delay output pulse from a negative input.

SYMBOL



3-UCB-1


-20V
R01A
6.8K
C01A
1000
μμF
R02A
1.5K
CR04A
R03A
22K
+20V
R07A
6.8K
R06A
6.8K
Q01A
2N711B
CR05A
R11A
2.7K
C02A
470μμF
Q02A
2N1379
R08A
12K
R10A
10K
R09A
6.8K
R04A
2.2K
T.P.A
R05A
470
CR01A
CR02A
CR03A
CR01B
CR02B
CR03B
CR01C
CR02C
CR03C
R01B
6.8K
R02B
1.5K
R03B
22K
R04B
4.7K
Q01B
2N711B
T.P.B
R05B
1K
R01C
6.8K
C01C
1000
μμF
R02C
1.5K
R03C
22K
R04C
4.7K
Q01C
2N711B
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11
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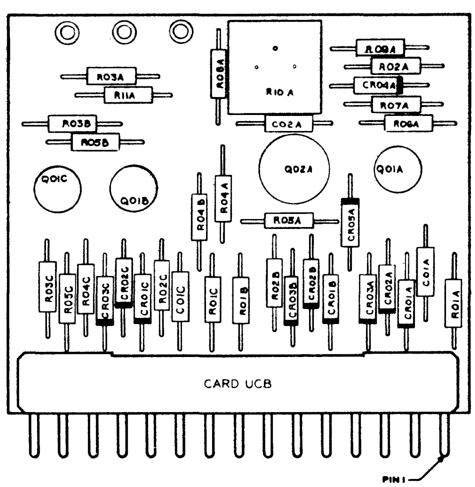
14
15


R10A
CARD UCB
PIN 1

3-UCB-2

VOLTAGE CONTROLLED DELAY

UFA, UFB

The voltage controlled delay circuit provides several options in delay duration and in the type of output signal desired at the end of the delay timeout by the use of external jumpers. It may have its delay controlled remotely by an analog d-c voltage in applications such as remote read and write deskew. It is also possible to use the circuit as a voltage comparator over a limited range.

The delay period is armed by having a "1" input on pin 1 for 0.5 usec or more for delay capacitors up to 5000 pf total. While armed and during the delay period, the output of circuit A (pins 5 and 6) is a "0" and the output of circuit C (pins 11 and 12) is a "1". The delay period is initiated by an input on pin 1 going from a "1" to a "0". The input must remain a "0" during the delay period, or the delay rearms and does not time out. When the delay period times out, the output of circuit A goes to a "1" and the output of circuit C goes to a "0". Grounding pin 10 delays the output of circuit C going to a "0" for 1 to 3 usec. Thus a "1" coincidence at the end of the delay may be obtained by ANDing one diode from each of the two outputs. For delays below 10 usec, where the optional capacitor on pin 4 is not used in the delay circuit, pin 10 may be connected to pin 4 and reduce the "1" coincidence by 30% or more. Other external capacitors can be used instead; but care should be exercised with external capacitors or the "1" coincidence may go to zero, particularly when the voltage on pin 9 is less than -8v. Long delays cannot reliably utilize the "1" coincidence feature of this circuit.

Q01 and Q02 form an inverter-emitter follower combination for discharging C02 (and any other capacitors connected to pin 7). Q03 and Q04 act as a differential comparison amplifier and switch close to the point at which pins 7 and 9 have equal voltage. This determines the timeout period which switches output circuits A and C. The RC timeout period is controlled by several factors, nearly all of which are accessible to output pins for optional timing periods. Pin 7 allows external capacitors to be added for a coarse step adjustment. Pin 2 may be used to clamp the voltage (usually about -10v) used in the RC charge circuit. Pin 3 permits some of the charge resistance to be shorted out; however, care should be taken to make sure the maximum current in potentiometer R15 does not exceed 7 ma under any possible condition. Internal potentiometer R15 provides a fine vernier adjustment of the RC charge curve. The voltage on pin 9 determines the comparison point of the delay timeout and can be from -1 1/2 to -10v. This may be a fine vernier adjustment remote to the card, or may be preset at about -5v without external connections, or preset to about -10v by jumpering pin 8 to 9. Very low voltages on pin 9 permit delays down to about 0.2 usec to be obtained. Gating diodes (or transistors) on analog voltage circuit cards permit the voltage on pin 9 to be "ORed" from any of several analog voltage sources. Similar techniques can be used internally or remotely to program different delay times to one delay circuit.

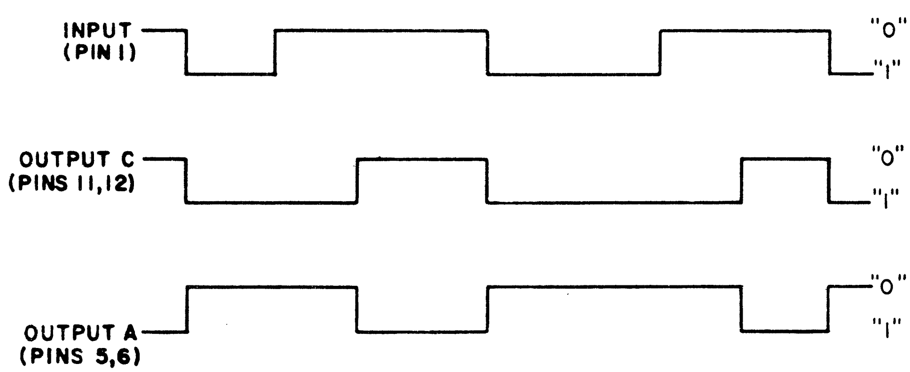
Q05 and Q06 are the output switching transistors which provide standard logic excursions. C04 delays the turn on of Q05 if connected directly to ground or via another capacitor to ground.

For best independence from power supply variations, the voltage on pin 9 and the voltage used to charge C02 should track with each other and not have significant variations within the timeout period.

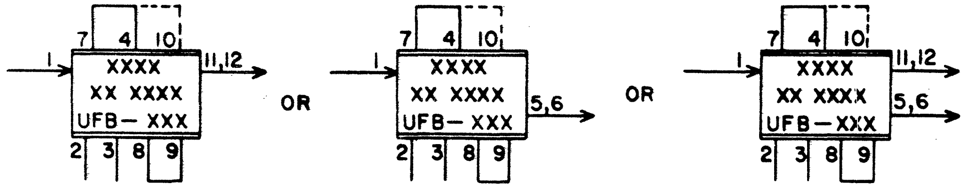
If the circuit is used as a voltage comparator in the usable -1 1/2 to -10v range, Q01 and Q02 should be disabled by a "0" on pin 1. The most rapidly changing voltage should be generally connected to pin 9 and the less dynamic voltage connected to pin 7 to minimize the need to drive charge current in C02.

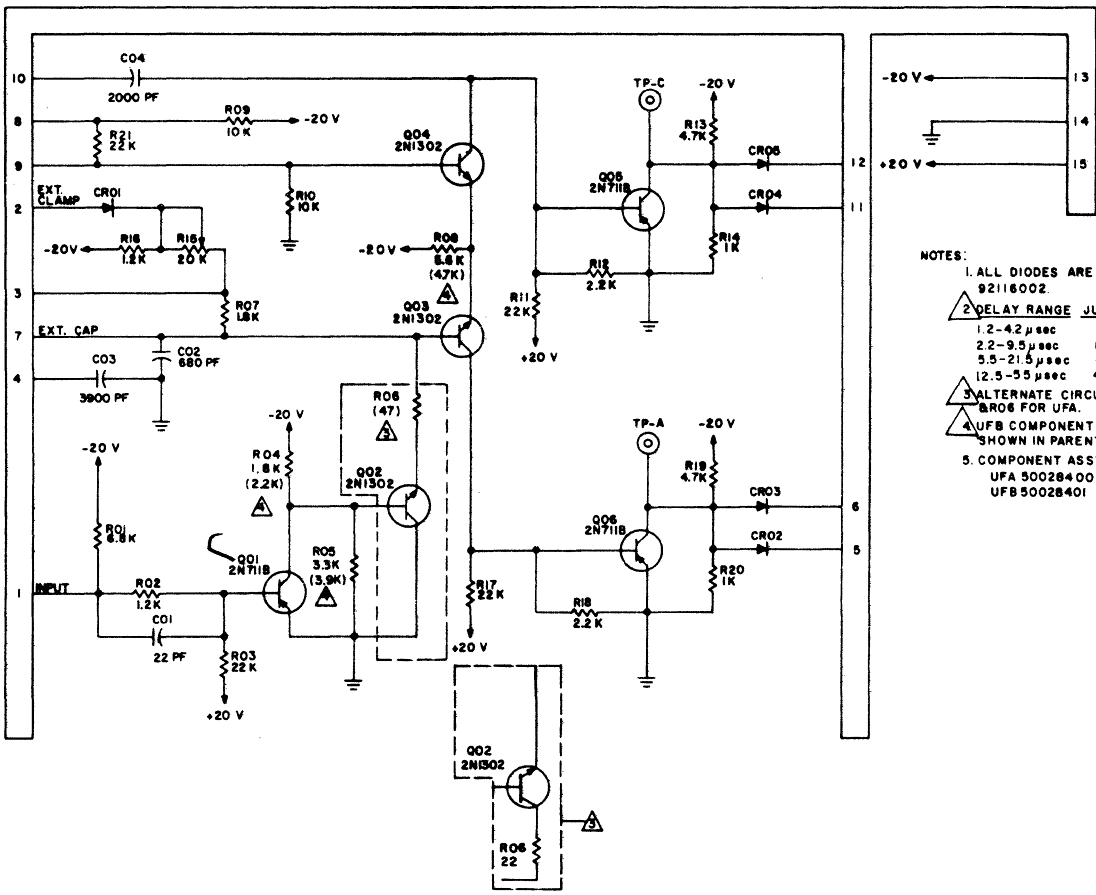
The logic symbol for the voltage controlled delay circuit shows the C output circuit (pins 11, 12) directly opposite the input. The A output circuit (pins 5, 6) is never directly opposite the input even if the C output is not used.

Waveforms for the input and outputs are shown below.



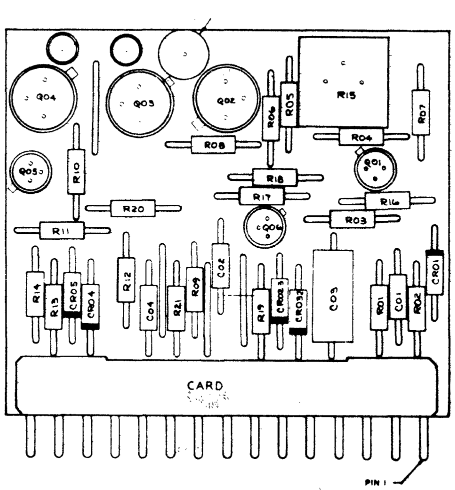
SYMBOL

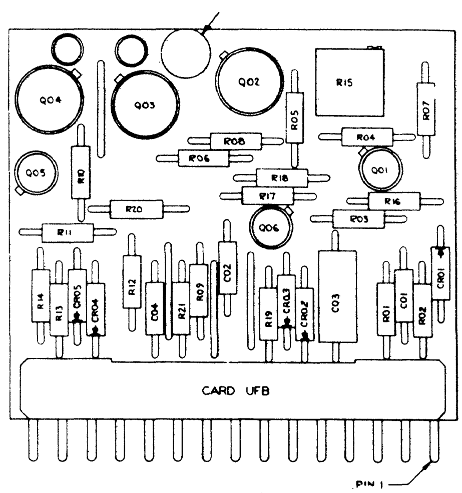




NOTES:

1. ALL DIODES ARE GERMANIUM 92116002.
2. DELAY RANGE / JUMPER PIN
   - 1.2–4.2 μsec —
   - 2.2–9.5 μsec 8-9
   - 5.5–21.5 μsec 4-7
   - 12.5–55 μsec 4-7 AND 8-9
3. ALTERNATE CIRCUIT OF Q02 & R06 FOR UFA.
4. UFB COMPONENT DIFFERENCES SHOWN IN PARENTHESIS.
5. COMPONENT ASSY NO.
   UFA 50028400
   UFB 50028401





APPENDIX C

CHARACTERISTICS OF 60X TAPE TRANSPORTS

APPENDIX C

CHARACTERISTICS OF 60X TAPE TRANSPORTS

CONTROL DATA 603

MAGNETIC TAPE TRANSPORT

RECORDING FORMAT
- Method-NRZ1 (non-return to zero-change on ones)
- Seven Track Recording
  - Data-6 bits
  - Parity-1 bit
- Inter-Record Gap-3/4 inch
- Tape Markers
  - Reflective spot for End of Tape and Beginning of Tape
- Compatible with all Control Data tape units and with IBM 727 and 729 I through IV Tape Units.

TAPE
- Width-1/2 inch
- Length-2400 feet with 1 1/2 mil base polyester tape
- Reels-10 1/2 inch, IBM compatible hub with file-protect ring

TAPE SPEED
- Read/Write-75 inches per second
- Forward and Reverse Search-75 inches per second
- Rewind and Unload-over 320 inches per second
- Start time-2.75$\pm$.5 milliseconds
- Stop time-2.25$\pm$.5 milliseconds

RECORDING DENSITY
- High-556 frames per inch
- Low-200 frames per inch

CHARACTER RATE
- 41,700 per second @ High Density
- 15,000 per second @ Low Density

HEADS
- Physical Spacing: (forward direction)
  - Erase gap to write gap-7/16 inches
  - Write gap to read gap-0.300 inches

CONTROLS
- Operator's Panel
  - Power
  - Forward
  - Reverse
  - Clear
  - Rewind
  - Unload
  - Load
  - Ready
  - High Density
  - Low Density
- Unit No. Selector
  - 0-7 and Standby
- Indicators
  - Read
  - Write
  - File Protect
  - Unit Select Status (2)

PHYSICAL
- Size: Height-72 inches
  - Depth-35 inches
  - Width-28 inches
- Weight-1200 pounds
- Power-208v, 3 phase, 60 cycle, 3.8 KW, 4.8 KVA
- Cooling Requirements-13,000BTU/HR

CONTROL DATA® 604

MAGNETIC TAPE TRANSPORT

RECORDING FORMAT
- Method-NRZ1 (non-return to zero-change on ones)
- Seven Track Recording
  - Data-6 bits
  - Parity-1 bit
- Inter-Record Gap-3/4 inch
- Tape Markers
  - End of tape and Load Point Reflective spot
- Reverse Read
  - 604 can read in the reverse direction with tapes prepared on other 604's in the same system.
- Compatible with all Control Data tape units and with IBM 727 and 729 I through VI tape units.

TAPE
- Width-1/2 inch
- Length-2400 feet with 1 1/2 mil base polyester tape
- Reels-10 1/2 inch, IBM compatible hub with file-protect ring

TAPE SPEED
- Write, Forward-75 inches per second
- Read, Forward and Reverse - 75 inches per second
- Search, Forward and Reverse-75 inches per second
- Rewind and Unload-over 320 inches per second average
- Start time-2.75± .5 milliseconds
- Stop time-2.25± .5 milliseconds

SELECTABLE RECORDING DENSITY
- 800 frames per inch
- 556 frames per inch
- 200 frames per inch

CHARACTER RATE
- 60,000 per second @ 800 frames per inch
- 41,700 per second @ 556 frames per inch
- 15,000 per second @ 200 frames per inch

HEADS
- Physical Spacing: (forward direction)
  - Erase gap to write gap-7/16 inches
  - Write gap to read gap-0.300 inches

PANEL
- Operator Controls with Indicators
  - Power
  - Forward
  - Reverse
  - Rewind
  - Unload
  - Load
  - 200 Density
  - 556 Density
  - 800 Density
  - Ready
  - Clear
  - Unit No. Selector
- Operator Indicators Only
  - Read
  - Write
  - Unit Select Status (2)
  - File Protect

PHYSICAL
- Size: Height-72 inches
  - Depth-35 inches
  - Width-28 inches
- Weight-1200 pounds
- Power-208v, 3 phase, 60 cycle, 3.8 KW, 4.8 KVA
- Cooling Requirements-13,000 BTU/HR

CONTROL DATA® 606

MAGNETIC TAPE TRANSPORT

RECORDING FORMAT

Method-NRZ1 (non-return to zero-change on ones)

Seven Track Recording
- Data-6 bits
- Parity-1 bit

Inter-Record Gap-3/4 inch

Tape Markers
- End-of-Tape & Load Point reflective spot

Compatible with all Control Data tape units and with IBM 727 and 729 I through IV Tape units.

TAPE

Width-1/2 inch

Length-2400 feet with 1 1/2 mil base polyester tape

Reels-10 1/2 inch, IBM compatible hub with file-protector ring

TAPE SPEED

Read/Write-150 inches per second

Reverse Movement-150 inches per second

Rewind and Unload-over 320 inches per second average

Start time-2.75±.5 milliseconds

Stop time-1.75±.5 milliseconds

RECORDING DENSITY

High-556 frames per inch

Low-200 frames per inch

CHARACTER RATE

83,400 per second @ High Density

30,000 per second @ Low Density

HEADS

Physical Spacing: (forward direction)
- Erase gap to write gap-7/16 inches
- Write gap to read gap-0.300 inches

PANEL

Operator Controls with Indicators
- Power
- Forward
- Reverse
- Rewind
- Unload
- Load
- Density Hi
- Density Low
- Ready
- Clear
- Unit No. Selector

Operation Indicators Only
- Read
- Write
- Unit Select Status
- File Protect

PHYSICAL

Size: Height-72 inches
Width-28 inches
Depth-35 inches

Weight-1200 pounds

Power-208v, 3 phase, 60 cycle, 3.8 KW, 4.8 KVA

Cooling Requirements-13,000 BTU/HR

CONTROL DATA® 607

MAGNETIC TAPE TRANSPORT

RECORDING FORMAT
- Method-NRZ1 (non-return to zero-change on ones)
- Seven Track Recording
  - Data-6 bits
  - Parity-1 bit
- Inter-Record Gap-3/4 inch
- Tape Markers
  - End of tape and Load Point Reflective Spot
- Reverse Read
  - 607 can read in the reverse direction with tapes prepared on other 607's in the same system.
- Compatible with all Control Data tape units and with IBM 727 and 729 I through VI tape units.

TAPE
- Width-1/2 inch
- Length-2400 feet with 1 1/2 mil base polyester tape
- Reels-10 1/2 inch, IBM compatible hub with file-protect ring

TAPE SPEED
- Write, Forward-150 inches per second
- Read, Forward and Reverse-150 inches per second
- Search, Forward and Reverse-150 inches per second
- Rewind and Unload-over 320 inches per second average
- Start time-2.75 $\pm$ .5 milliseconds
- Stop time-1.75 $\pm$ .25 milliseconds

SELECTABLE RECORDING DENSITY
- 800 frames per inch
- 556 frames per inch
- 200 frames per inch

CHARACTER RATE
- 120,000 per second @ 800 frames per inch
- 83,400 per second @ 556 frames per inch
- 30,000 per second @ 200 frames per inch

HEADS
- Physical Spacing: (forward direction
  - Erase gap to write gap-7/16 inches
  - Write gap to read gap-0.300 inches

PANEL
- Operator Controls with Indicators
  - Power
  - Forward
  - Reverse
  - Rewind
  - Unload
  - Load
  - 200 Density
  - 556 Density
  - 800 Density
  - Ready
  - Clear
  - Unit No. Selector
- Operating Indicators Only
  - Read
  - Write
  - Unit Select Status
  - File Protect

PHYSICAL
- Size: Height-72 inches
  - Depth-35 inches
  - Width-28 inches
- Weight-1200 pounds
- Power-208v, 3 phase, 60 cycle, 3.8 KW, 4.8 KVA
- Cooling Requirements-13,000 BTU/HR

APPENDIX D

EXPLANATION OF SPECIAL COMPONENTS

IN THE 606 MAGNETIC TAPE TRANSPORT

1. REED DELAY
2. SILICON CONTROLLED RECTIFIER (S.C.R.)
3. ZENER DIODE

REED RELAY

The reed relay consists of two or more metal reeds enclosed in a hermetically sealed glass capsule. The reeds are made from nickel-iron, a magnetically "soft" alloy that retains only a little magnetism. Figure 1 shows a s.p.s.t., normally open reed relay. The overlapping ends of the nickel-iron reeds are the contact surfaces which are usually plated with gold or other suitable noble metal. A chemically inert gas which is enclosed in the capsule prevents contamination of contacts.

When an electromagnetic field comes in close proximity to the reed relay, more and more of its lines of force permeate the reeds causing mutual attraction between the reeds pulling them towards each other.

The reverse action takes place when the electromagnetic field is removed. As the electromagnetic field collapses, the magnetic remanence tends to keep the ends of the reed together. But since the reeds consist of a magnetically "soft" alloy, the point is soon reached where the decreasing flux is insufficient to hold the reeds together.

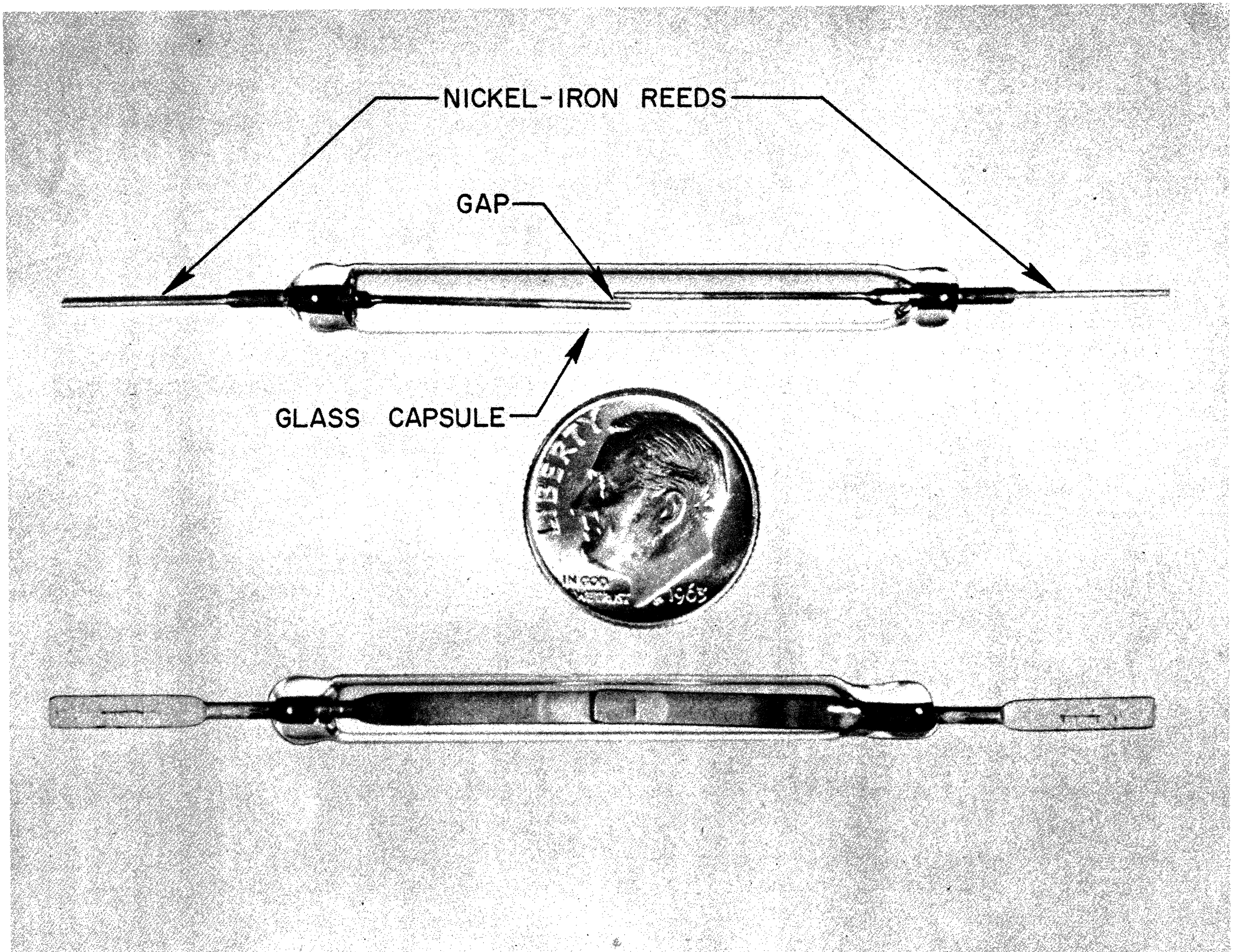


FIGURE 1C REED RELAY

THE SILICON CONTROLLED RECTIFIER

The silicon controlled rectifier is a 4-layer semiconductor sandwich which functions as an AC to DC rectifier. The distinctive feature is a gate connection by which the rectifier can be triggered into action, in the same way, by rough mechanical analogy, that a gun is fired by pulling the trigger. The timing of the gate firing can determine the phase and output of the rectifier and this is a valuable feature where controlled output is desired.

Until the availability of the Silicon Controlled Rectifier, the methods of obtaining instantly controllable DC from an AC source have been by means of the gas filled, grid controlled tube known as the Thyratron, and by means of the magnetic amplifier with rectifiers -- up till recently the selenium type. The Thyratron method was once used for E-M magnetic drive controllers, and was superseded years ago by the magnetic amplifier method.

Now, the new types of E-M controllers for magnetic drives use silicon controlled rectifiers to provide controllable AC-DC conversion, instead of the previous magnetic amplifier. And now the E-M brushless AC generators also use SCRs for the exciter field power supply in place of the magnetic amplifier. Both of these replacements provide a better product and better performance because of the superiorities of the Silicon Controlled Rectifier method. For the same reasons SCRs are also used in other controls. Silicon Controlled Rectifiers are also used in the brushless synchronous motor.

The Silicon Controlled Rectifier is a comparatively recent development. It has rapidly been made available in larger current ratings and the cost has gone down. With increasing SCR current capacities and with decreased costs the replacement trend with the SCRs will continue.

Operation of the SCR and its construction are shown in accompanying figures. As shown in FIGURE 2-C, the silicon controlled rectifier has two NP sandwiches and three junctions. A control gate connection is made to the first P element. The characteristics of the three junctions and the control achieved by the gate enable the rectifier to be actuated, or "fired", at will. The gate firing current can be exceedingly small and of exceedingly short duration. The same electron-hole and biasing principles involved in previously described semiconductors apply.

The double PN structure provides the capability of controllable conduction by means of hole injection through the gate, and this gives the SCR its unique and highly valuable properties.

The SCR has several advantages: It is lightweight and compact, occupying, with its heat sink, less space than the magnetic amplifier.

It is highly efficient.

It can be fired with very low power pulses, compatible to the capability of other semiconductor devices that can be used for the firing.

It can operate in microseconds. The SCR can go from minimum output in one half cycle to full output in the next without lag, at high frequencies.

The SCR can provide infinite gating variations over the cycle by methods such as phase control.

It can operate as an inverter {DC to AC} as well as a rectifier.

Life of the SCR is, in principle, unlimited.

Like the regular junction diode it is not affected by vibration, shock, or position, and can be part of a rotating element.

It is inherently a highly sensitive, high gain amplifier.

Its wide junction base construction makes it inherently suitable for high voltages.

These properties indicate an ever increasing field of application for SCRs. They can be operated not only as rectifiers, but also as latching switches, as voltage absorbers, and as amplifiers. As the latter they are capable of handling hundreds of amperes with only a few milliamperes of triggering power, thus in effect providing an extraordinarily large gain capability.

SCRs are subject to the same temperature considerations and limitations, and require the same protection against overcurrent and overvoltage surges as was discussed under junction diode rectifiers. Their allowable ratings also follow the voltage and current limitation parameters listed under junction diodes, with the addition of limitations applying to the gate.

The silicon controlled rectifier is a junction rectifier with the highly useful feature of controllability of its current conduction. The junction configuration of the SCR is such that it requires an impetus, either by sufficient forward voltage, or by injection of gate current, to change it from a blocking state to a conduction state. The gate current method of output control of the SCR is the valuable feature because it permits pre-determining timing.

HOW THE SILICON CONTROLLED RECTIFIER WORKS

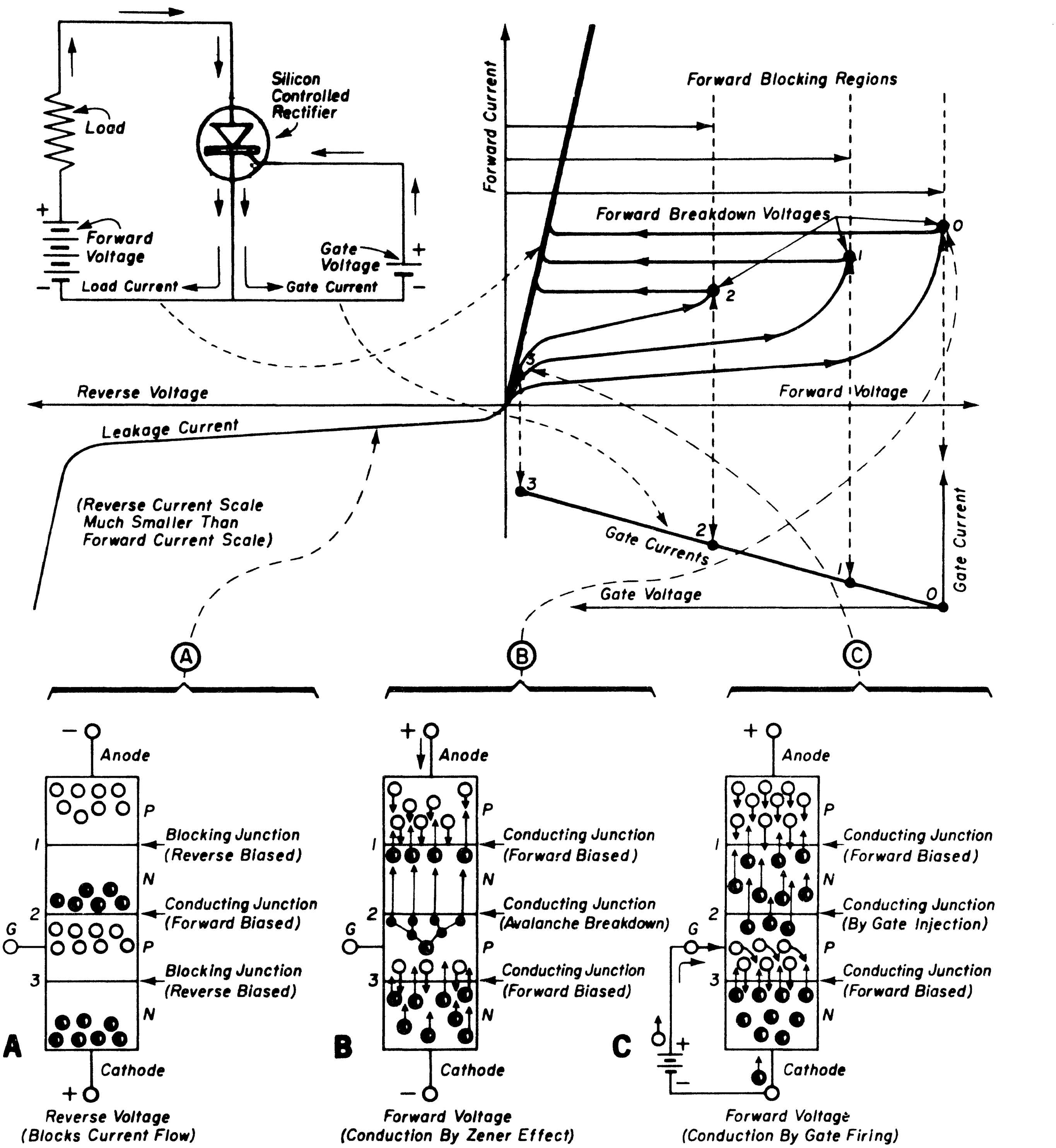


Figure 2C

Accompanying figures show the configuration of the SCR and its operation in three conditions. The voltage-current characteristics for these conditions are shown in the graph. The PNPN arrangement provides a controllable junction shown as junction number 2 in the drawings A, B and C above.

{A} At reverse voltage the SCR has two junctions, 1 and 3, which are reverse biased, hence which block current flow. These give the SCR the reverse voltage characteristics of the usual single junction PN diode rectifier, with very small leakage current unless the peak reverse voltage limitation is exceeded.

{B} At forward voltage the SCR has conduction junctions at 1 and 3, due to forward bias, and a blocking junction at 2 due to reverse bias. However, if sufficient forward voltage is applied to blocking junction 2 it will break down by an avalanche phenomenon described previously for the Zener diode. The SCR then becomes conducting with forward voltage and current characteristics similar to the usual PN diode rectifier.

{C} This figure shows controllable conduction, by gate current injection, when the SCR has forward voltage. By positive voltage injection into the gate the hole velocity in the P-type element and the electron velocity across junction 3 and through element P can be increased to achieve breakdown or firing of junction 2. The various values of gate current to accomplish this firing are shown in the graph.

With sufficient gate current, as shown at 3 on the gate current line, the SCR fires as soon as it is in the forward voltage region. The voltage-current characteristic of the SCR is then the same as that of the usual PN two-element junction diode rectifier. {The gate current numbers shown in the diagram are for indication purposes only and do not represent actual current values.}

Gate injection thus provides an independent time-current method of controlling the operation of the rectifier. Once fired, the SCR remains conductive until the voltage across it falls to zero. The SCR then returns to its initial state, ready again for firing.

SILICON CONTROLLED RECTIFIER

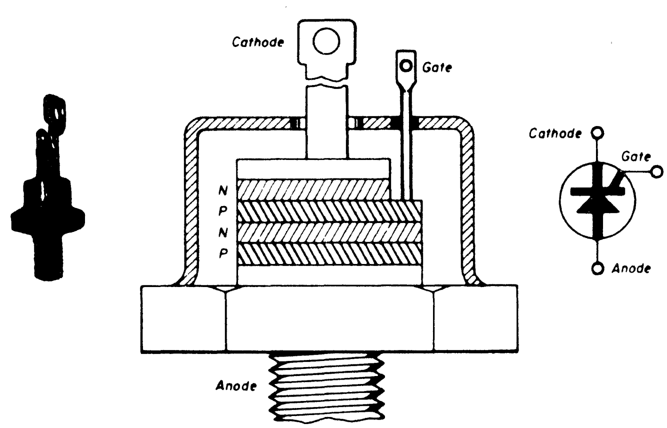


Figure 3C

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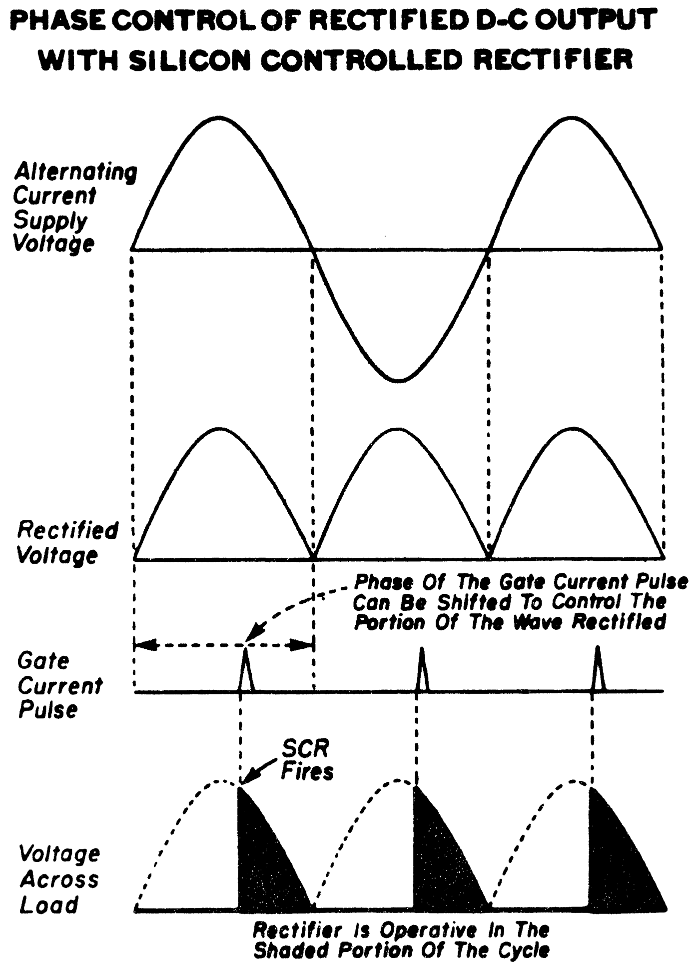


Figure 4C

The voltage and current applied to a load being supplied from an A-C source can be rectified and controlled by delaying the point in the A-C cycle at which the SCR changes from the blocking to the conduction condition. It provides in effect a phase controlled switch. The accompanying diagrams show how the output is controlled by the gate current pulse. By phase shift of the gate pulse, all or part of the cyclic output of the SCR can be utilized. Also, by absence of gate impulse, the SCR can be made inoperative during the cycle.

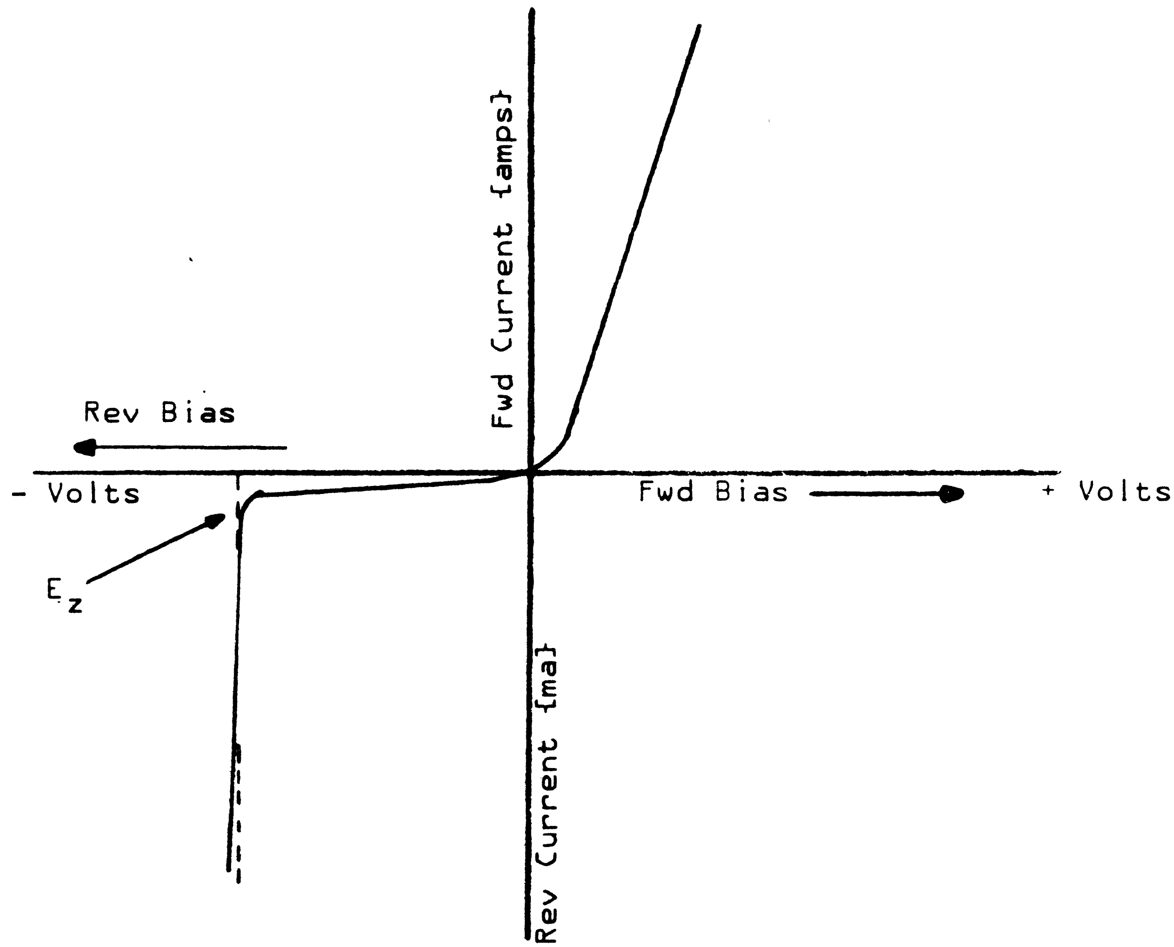
ZENER DIODE

When a semiconductor diode is reverse biased, a very small current will flow through the diode. If this reverse bias is increased to the point where a large reverse current starts to flow, the breakdown point has been reached. This is also called the breakdown region, avalanche breakdown, or zener voltage. Zener diodes are specially designed silicon diodes which are designed to operate using the zener voltage point to an advantage.

Once the zener voltage has been reached, any increase in reverse voltage will cause an increase in current with no additional increase in the voltage drop across the zener diode.

Figure 5C is the characteristic curve of a zener diode. When the zener diode is forward biased, it acts as a conventional diode, i.e., an increase in forward bias results in additional current through the diode with additional voltage drop across the zener.

With reverse bias, little current flows until the "zener" point is reached. After this point is reached, the voltage across the zener is shown remaining constant.



-4.7
-5.6
-6.8
-8.2
-10.0
-12.0
-15.0

Common
Zener Points

Figure 5C Zener Characteristic Curve

APPENDIX E

GLOSSARY OF TERMS

USED IN

MAGNETIC RECORDING EQUIPMENT

▽A▽ WIND - When a reel of Magnetic Tape is wound with the base side of the tape toward the outside, it is said to be an ▽A▽ Wind tape. This type of wind is most common.

ADDITIVE - In the process of manufacturing magnetic tape the coating is comprised of the oxide material, the binders, and other materials. These other materials are referred to as additives. These additives serve the purpose of making the binder more pliable {Plasticizers}, reducing the friction of the binder {Lubricants}, and preventing fungus growth {Fungicides}.

AXIMUTH ALIGNMENT - The alignment of the recording and reproducing gaps is azimuth or so that their centerlines are parallel to each other.

▽B▽ WIND - A reel of magnetic tape wound with the oxide toward the outside.

BASE FILM - Commonly referred to as the base. The plastic that the coating is placed on. The base of most tapes used in conjunction with computers is polyester.

BINDER - The material used in the process of manufacturing magnetic tape to bond the oxide particles in the coating. Usually composed of organiz resins.

BIT DENSITY - The amount of digital information placed in one longitudinal inch of tape. Usually referred to as bits per inch. {B.P.I.}. Densities are usually 200, 556, or 800 BPI.

BLOCKING - The term applied to the tendency for adjacent layers of tape on a reel to stick, or adhere. This occurs usually after the reel or tape has been stored under adverse conditions of high temperature and humidity.

BUCKLING - The condition where the concentricity of the reel of tape is deformed due to improper winding, tension or storage under adverse conditions.

BULK DEGAUSSER - A device used to erase an entire roll of tape. A reel of tape is placed on the device and rotated while the 60 cycle erasing field is decreased.

BULK ERASER - See Bulk Degausser...

CHANNEL - See Track.

CINCHING - The condition that occurs between the layers of tape when the reel is rapidly accelerated or decelerated.

COATING - The magnetic material applied to the base during manufacture of tape. The coating consists of the oxide particles and the binder.

COATING THICKNESS - The thickness of the magnetic coating applied to the base of a magnetic tape. Coatings range in thickness from 170 to 650 microinches.

CUPPING - The term applied to the curvature of tape in a lateral or transverse direction.

CORE - A magnetic material that affords an easy path for magnetic flux lines in a coil.

DEFECT - Any imperfection in magnetic tape that may lead to loss of information due to dropout or signal decrease.

DIGITAL RECORDING - Magnetic Tape recording in which the information recorded is in terms of two discrete values.

DROPOUT - A temporary reduction in output of more than a predetermined amount. Usually expressed in terms of the percentage of reduction.

ERASURE - The process of neutralizing the magnetic pattern on a magnetic tape. This removes previously recorded information and is usually performed just prior to recording new information.

ERROR - The term given to a dropout or a noise pulse that exceeds a predetermined value.

FLUX FIELD - All electric or magnetic lines of force in a given region.

FREON-{TF} - Trifluorotri chloroethane -- a water-white liquid, non-flammable and noncombustible used in cleaning magnetic tape and tape transports.

GAP - The distance between the poles of a recording head, measured in mils. The gap is a deciding factor in the frequency response of a head. The smaller the gap, the higher the frequency range.

GAP LENGTH - The dimension of the gap of a record head measured from one pole face to the other pole face.

GAP WIDTH - The dimension of the gap measured parallel to the pole face. The Width determines the width of the track on tape.

HEAD - The term applied to the device that performs the actual ▽Writing▽ on tape or ▽Reading▽ from tape. Basically a ring shaped electromagnet across which magnetic tape is drawn.

HEAD ALIGNMENT - The physical placement of the read/write head assembly so that the gaps are perpendicular to the longitudinal axis of tape travel.

LINE OF FORCE - A line in a magnetic field that shows the direction of the force.

LONGITUDINAL PARITY - Parity for each track.

MAGNETIC FIELD - The space in which a magnetic force exists.

MAGNETIC FLUX - The total number of lines of force issuing from a pole of a magnet.

MIL - One thousandth of an inch.

MOLECULE - The smallest particle of any substance which can exist free and still exhibit all the chemical properties of the substance.

MYLAR - The DuPont trade name for polyethelyne terephalate, a durable plastic used as a base for magnetic tape.

NRZI - Non-return-to-zero indiscrete. A method of recording whereby a binary "one" is recorded by a reversal of current direction, and a binary "zero" is recorded by no reversal of current.

PERMEABILITY - A measure of the ease with which magnetic lines of force can flow through a material as compared to air.

POLARITY - The character of having magnetic poles.

RAW TAPE - A term applied to magnetic tape that has not been recorded.

RELUCTANCE - A measure of the opposition that a material offers to magnetic lines of force.

RETENTIVITY - The measure of the ability of a material to hold its magnetic strength.

SKEW - Misalignment of bits recorded on tape. There are two types of skew: 1) Static 2) Dynamic.

Static Skew is caused by misalignment of heads or non-uniformity of head construction.

Dynamic skew is caused by curved tape, changes in tape guiding, circuit instability, reel wobble, and anything which will cause a mechanical oscillation or jitter to the tape.

SPLICING TAPE - A special, cold-flow, pressure sensitive, non-magnetic tape used to splice magnetic tape and to apply latch leaders to magnetic tape.

TRANSDUCER - A device by means of which energy can be transmitted from one unit to another. The input and output energies can be of the same form or different forms.

TRANSVERSE - Vertical recording. Perpendicular to the edge of the tape.

TRANSVERSE PARITY - Parity for each frame.

COMMENT SHEET

MANUAL TITLE 606 MAGNETIC TAPE STORAGE EQUIPMENT TRAINING MANUAL

PUBLICATION NO. 60239400 REVISION A

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