INSTRUCTION MANUAL

MODEL 400-01 -02

"TENTROL"

August 1974

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I. GENERAL INFORMATION

TENTROL is a tape tension control kit which is active in the Record and Reproduce modes of a tape recorder. The Model 400-01 and 400-02 kits will control holdback tension on Ampex Models 440C and 440C-8 respectively. TENTROL does not disturb the tape path, utilizing instead the exsisting motion sense tachometer on the holdback motor. For takeup applications, a Model 400-00 TENTROL kit is required.

When TENTROL is adjusted for constant holdback tension, the following advantages are gained:

1. Speed and timing accuracy are improved because capstan slippage caused by excessive tension differential across the capstan is significantly reduced.
2. Pitch change from beginning to end of reel is eliminated since it is caused by change in tape length with tension variations.
3. Poor transport starting characteristics, caused by capstan slippage while the reel idler accelerates, can be eliminated by the reduction of excessive tension.
4. Head life can be increased by eliminating excessive tape tension.
5. High frequency response is improved through consistent head-to-tape pressure and through reduction of tape tracking, and consequent azimuth variations caused by tension changes.
6. In multi-channel recorders, phase shift variation from beginning to end of reel is improved through the improvement in tape tracking.

The Inovonics Model 400-01 and 400-02 TENTROL kits consist of an electronic control module, 6" long, 4½" wide, 2½" high, plus a ten-wire cable assembly that is connected to the transport control circuitry and plugs into the TENTROL control module.

TENTROL SPECIFICATIONS

Applicable to:

Model 400-01: Ampex Models 440C-1 through 440C-4, ¼" or ½" tape. holdback applications only.

Model 400-02: Ampex Model 440C-8, holdback applications only.

Reel Sizes:

"Cine" (1-7/8" hub) through 10½" with NAB hub.

Nominal Constant Tension at Head:

Adjustable from 3 to 9 ounces within motor torque limits

Tension Variation Throughout Reel:

±½ oz.

Maximum Torque Available:

90% of maximum rated motor torque

Power Line Voltage:

Provided by tape transport

Power Line Frequency:

50 or 60Hz.

Additional Features:

1. Adjustable starting torque for optimum starting characteristics.
2. Two tension adjustments allow for close matching of tension requirements to the motor characteristics and provide the capability of changing tension with pack size for special requirements.
3. A switch on the Control Module allows selection of constant torque operation for special requirements.

II. INSTALLATION

Upon receipt of the equipment, inspect for shipping damage. Should any such damage be observed, notify the carrier at once; if not, proceed as outlined below. It is suggested that the original shipping carton and materials be saved should future re-shipment become necessary.

2.1 Control Module Mounting

The Control Module may be mounted in any convenient place, either on the transport, console cabinet, or rack. It may be mounted in any position; however it should be remembered ahat the TENTROL must dissipate all the power previously dissipated in the tension adjusting resistors. If high ambient temperatures are anticipated, it is recommended that the Module be mounted with the heat sink fins vertical for maximum convection cooling.

2.2 Circuit Connections - Ampex 440C-1 to -4 (400-01 TENTROL)

2.2.1 Remove the cover of the transport control box.. If the transport is equipped with a DC capstan servo, connect a jumper wire between pin 2 and pin 4 of the servo electronics connector J 604.

2.2.2 If TENTROL is to be used on the holdback motor, cut and insulate the wire that goes from the rewind relay K 601 term. 2 to the holdback tension resistor R 607.

2.2.3 Connect the ends of the wires of the two cables to the following points in the transport control box:

CABLE CONDUCTOR	CONNECT TO	CONTROL FUNCTION
Brown (AC capstan motor)	J 602 pin 1	Speed
Brown (DC servo motor)	J 602 pin 4	Speed
Red	Pos. end C 609 (150uF, 200V)	+130VDC
Orange	K 602 term. 7 or TB 2 term. 2	+ Caps. Sol.
Yellow	Neg. end C 609 (150uF, 200V)	- Caps. Sol
Blue	J 604 pin 3	117VAC hot
Violet	J 604 pin 8	+24VDC
Inner cond,shielded	J 607 pin 3	photocell
Shield	J 607 pin 5	chassis ground

Green	empty lug on rewind reel size switch S610	reel size
Grey	J 607 pin 2	Motor "hot"

2.3 Circuit Connections - Ampex 440C-8 (400-02 TENTROL)

2.3.1 Remove the cover of the transport control box. Unplug the Supply Reel Start Torque Delay Box located on the console shelf. This assembly is not needed because TENTROL supplies the necessary delay.

2.3.2 Connect the ends of the wires of the two cables ıle to the following points in the transport control box:

CABLE CONDUCTOR	CONNECT TO	CONTROL FUNCTION
Brown	no connection	
Red	Pos. end C 614 (150uF, 200V)	+130VDC
Orange	K 602 term. 7	+ Caps. Sol.
Yellow	Neg. end C 614 (150uF, 200V)	- Caps. Sol.
Green	J 606 pin 6	+39V Hi Speed
Blue	J 604 pin 5	117VAC "hot"
Violet	J 602 pin 8	+30VDC
Grey	J 607 pin 2	Motor "hot"
Inner cond,shielded	J 607 pin 3	photocell
Shield	Chassis ground	ground

III. ADJUSTMENT

3.1 General

CAUTION

TENTROL CIRCUITRY AND TEST POINTS 1,2, AND 3 ARE CONNECTED TO THE AC POWER LINE. MAKE SURE THAT ANY TEST INSTRUMENTS USED ARE FREE FROM GROUND.

IN THE TESTING OF TENTROL, SOME TEST EQUIPMENT CHASSIS WILL BE AT POWER LINE POTENTIAL. SHOCK HAZARD WILL EXIST - TAKE EXTREME CARE!

Tach sensitivity adjustment requires an oscilloscope. The easiest method for adjusting TENTROL tape tensions is to use a tension meter such as the Tentel Model T2-H20-MS (Tentel, 1210 Camden Ave., Campbell, CA 95008) A DC voltmeter plus a spring scale may also be used for tension adjustment. Both methods will be described. For holdback applications, we recommend the following tape tensions at the input to the head assembly: ¼" tape, 4 oz.; ½" tape, 6 oz.; 1" tape, 8 oz. These nominal tensions are none too critical and can be varied as much as ±2 oz. with no adverse effects. The important consideration for azimuth and speed stability is to keep the tension from beginning to end of reel as close as possible to the nominal selected. If you have a problem of slow speed during starting, the tension should be kept on the low side of nominal. If you have a problem with high frequency signal variation, the tension can be adjusted to the high side of nominal to increase the tape-to-head pressure. In takeup applications the tension selected is a matter of personal preference. For ¼" tape the maximum tension at the input to the takeup reel should be limited to 8 oz. Improved tape packing may result if the tension is adjusted to be a compromise between constant torque and constant tension so that the tension decreases somewhat as the reel pack gets larger.

3.2 Tachometer Sensitivity Adjustment

3.2.1 To verify that the installation has been properly made, thread a piece of junk tape on the recorder. Place the Run-Setup switch in Setup and check that the transport functions normally in all operating modes.

3.2.2 Connect an oscilloscope to TP-1 and TP-3, common to TP-3. CAUTION: MAKE SURE THE 'SCOPE IS UNGROUNDED SINCE THESE TEST POINTS ARE AT POWER LINE POTENTIAL. THE 'SCOPE HOUSING MAY ALSO BE AT POWER LINE POTENTIAL.

3.2.3 Place the TENTROL Run-Setup switch in Run. Select the low tape speed of the transport. Start the transport in the Play mode.

3.2.4 Adjust R 1 until a sawtooth wave appears. Fine-adjust R 1 so that the amplitude of adjacent pulses are approximately equal in peak-to-peak amplitude (variation less than 20%). Note: It may be necessary to readjust the photocell bracket to center it on the tachometer disc.

3.3 Adjustment Using a Tension Gauge

3.3.1 Thread a reel of tape with the minimum hub size you intend to use. Either speed may be selected. Place the reel size switches in the large reel position regardless of the reel size used. Fast-wind the tape such that only ½" of tape remains on the supply reel. If adjusting for ½" or 1" tape, make sure Full Reel Tension adjust control, R16, is fully clockwise. Place the Run-Setup switch in Run. Start the machine, and after the reel idler comes up to speed, insert the tension gauge between the reel idler and the head assembly. Make sure the tape touches all three prongs of the gauge. Adjust the Empty Reel Tension control, R 9, for the naminal tension desired. When making a takeup installation, measure the tension at the input to the takeup reel.

3.3.2 Thread a reel of tape with the maximum diameter

you intend using, and fast-wind until the tape is ½" from full. Start the machine and adjust the Full Reel Tension control, R 16, for nominal tension desired.

3.3.3 Fast-wind the tape and spot check several places between minimum and maximum tape packs and make compromise adjustments if required. Always make sure the reel idler has come up to speed. This could take 10 seconds at the higher tape speeds, but is easily noticed on the tension gauge as a sudden drop in tension. When making a compromise adjustment, it should be noted that the Empty Reel Tension control, R 9, affects the tension throughout the tape pack; whereas the Full Reel Tension control, R 16 will have no effect when the motor torque is low (small reels with tape diameter less than 4").

3.3.4 Up to this point all tension measurements were made with both reel switches in the large reel position. Movement of the holdback reel size switch has no effect on the holdback tension; however, change of the takeup reel size switch from large to small will cause a slight reduction in holdback tension. This is caused by the fact that the fast winding holdback resistor is connected between the two motors in the play mode as well as in the fast winding modes. Since the takeup reel size switch changes the voltage to the takeup motor, this change is fed to the holdback motor through the fast winding resistor and changes the holdback motor voltage slightly. Normally this change will not exceed ½ oz. The effect may be minimized by increasing the small reel tension to 4 oz. measured on an NAB hub, and reducing the fast winding holdback torque if it is adjustable.

3.3.5 The Starting Torque adjustment, R 23, cannot be stated to be optimum at a given number of ounces. It

will vary with the transport model and with the spring tensions in the reel idler arm and the takeup tension arm. When TENTROL is used on holdback, the starting torque should be kept low to minimize capstan slippage. If too low, however, the tape will bounce off the heads during starting. The best method of making this adjustment is to reproduce a pre-recorded tape and adjust for the best sounding starts. Make sure to check the beginning and the end of the reel. When TENTROL is used on takeup, the starting torque is normally set high to minimize the loop thrown at the takeup tension arm. Again, a listening test is the best aid in adjustment.

3.4 Adjustment Using a Spring Scale and a DC Voltmeter

3.4.1 In this method of adjusting tension, the DC control voltage required to produce the desired motor torque for a number of reel diameters is determined by static test, and then programmed into the unit as it operates in the Play mode.

Since there is a buildup of tension around the reel idler tape guide, the tension at the supply reel will not be the same as the head input tension. The tension buildup depends upon the wrap around the tape guide which will vary with the absolute tension, reel idler spring tension, and style of transport. At low absolute tensions it also varies with pack diameter.

TABLE 1 charts the holdback motor torque in ounces at the NAB hub diameter of 4½", for various tape pack diameters and for several nominal constant tape tensions (at the head). This table is used in the Spring Scale and DC Voltmeter method of TENTROL holdback setup. When setting up takeup torque requirements at the input to the

takeup reel, TABLE 1 is not required. The torque required at the NAB hub diameter of 4½" can be easily calculated as the nominal tension desired times the pack diameter in inches, divided by 4½ (inches).

TABLE 1

HOLDBACK MOTOR TORQUE REQUIREMENTS

PACK DIAMETER	NOMINAL HOLDBACK TENSION AT HEAD INPUT 4 oz.	5 oz.	6 oz.	8 oz.
3"	2.1	2.7	3.4	4.7
5"	3.5	4.5	5.7	7.8
7"	4.8	6.3	8.0	10.9
9"	6.1	8.0	10.2	14.0
12"	8.0	10.6	13.6	*

MOTOR TORQUE IN OUNCES AT AN NAB 4½" HUB USING A SPRING SCALE AND TWINE

* Insufficient motor torque available

PROCEDURE:

3.4.2 Connect the TENTROL Control Module to the transport, setting the RUN - SETUP switch to Setup. Attach an NAB hub to the spring scale using twine, and place on the appropriate turntable. Hold or clamp the spring scale so that it remains stationary. Tape the takeup tension arm to enable the transport. Connect a DC voltmeter to TP-2 (positive) and TP-3 (negative). CAUTION: THE LEADS OF THIS METER WILL NOW BE AT POWER LINE POTENTIAL. The voltage to be measured will not exceed 5 volts.

3.4.3 Start the transport in the Play mode. Using TABLE 1, select a torque that corresponds with the desired nominal tension and the smallest pack diameter to be used.

Adjust the TENTROL Start Torque control, R 23, to produce this reading on the spring scale. (Tap the scale on occasion to make sure it isn't sticking.) Record the reading of the DC voltmeter alongside the minimum pack diameter in TABLE 1. Repeat this procedure for the other pack diameters, readjusting R 23 to give the required torque listed in TABLE 1 in each case. If EIA plastic reels will not be used, omit the 3" pack diameter reading. If 14" reels are not used, omit the 12" pack reading. When completed, your chart might look like this:

(For a constant holdback tension of 5 oz)

PACK DIA.	REQ'D MOTOR TORQUE	DC VOLTAGE MEASURED AFTER R 23 ADJUSTED
5"	4.5 oz.	3.2 V
7"	6.3 oz.	3.8 V
9"	8.0 oz.	4.2 V

3.4.4 Remove the spring scale. If EIA reels will be used, mark an EIA reel and an NAB reel with marks to identify the pack diameters of TABLE 1. Thread the smallest reel of tape to be used on the transport and fast-wind to the smallest diameter listed in TABLE 1. Place the TENTROL RUN - SETUP switch in Run. Start the tape in the Play mode at either tape speed. Adjust the Empty Reel Tension control, R 9, to give the DC voltage reading measured in step 3.4.3 that corresponds with the appropriate minimum pack diameter.

3.4.5 Thread a reel of tape with the maximum pack diameter to be used, and fast-wind to the maximum (TABLE 1) diameter mark. Start the tape and adjust the Full Reel Tension control, R 16, to give the DC voltage measured in step 3.4.3.

3.4.6 Check the DC voltages at the other diameters listed in TABLE 1 and make a compromise adjustment if necessary. If the spring scale measurements in step 3.4.3 are accurate, it should be possible to match the DC voltage requirements within ±0.1 volt. When making a compromise adjustment, it should be noted that the Empty Reel Tension control, R 9, affects the tension throughout the tape pack, whereas the Full Reel Tension control, R 16, will have no effect when the motor torque is low, as with small reels with tape pack diameter less than 4".

3.4.7 Adjust the Starting Torque control, R 23, as described in paragraph 3.3.5. This adjustment should always be the last step in the procedure. A change in the Full Reel Tension control, R 16, will also change the starting torque. Refer to paragraph 3.3.4 for the effect of the transport reel size switches on the operation of TENTROL.

IV. OPERATIONAL AND FUNCTIONAL DESCRIPTION

4.1 TENTROL Operation

There are no operating controls or procedures required when using TENTROL. Once adjusted, TENTROL will control the Record / Play mode tape tension to the desired tension - tape pack characteristics determined during the adjustment procedure. Variations in line voltage and temperature will have some effect upon absolute tension, but will have only minor effect on tension consistency throughout a reel. The largest variable in maintaining constant holdback tension at the head input is the wrap around the reel idler tape guide. If there is any stiction in the tape guide arm, the arm can choose various wrap angles for the same pack diameter, causing a tension change at the head input. This effect is only noticable with low nominal tensions, and is normally less than ½-ounce. If the sticktion should be severe, disassemble and clean the reel idler assembly.

TENTROL will only maintain constant tension when the tape speed is constant. If the transport is operated in a variable speed mode, the tension will be inversely proportional to the tape speed such that a 20% increase in speed will result in a 20% reduction in tension. If speed changes in excess of 20% are anticipated, the RUN - SETUP switch may be changed to the Set-up position. This will operate the transport in a constant torque mode regardless of the tape speed or the pack di-

ameter. The torque desired can be adjusted with the Start Torque control, R 23.

4.2 Functional Description

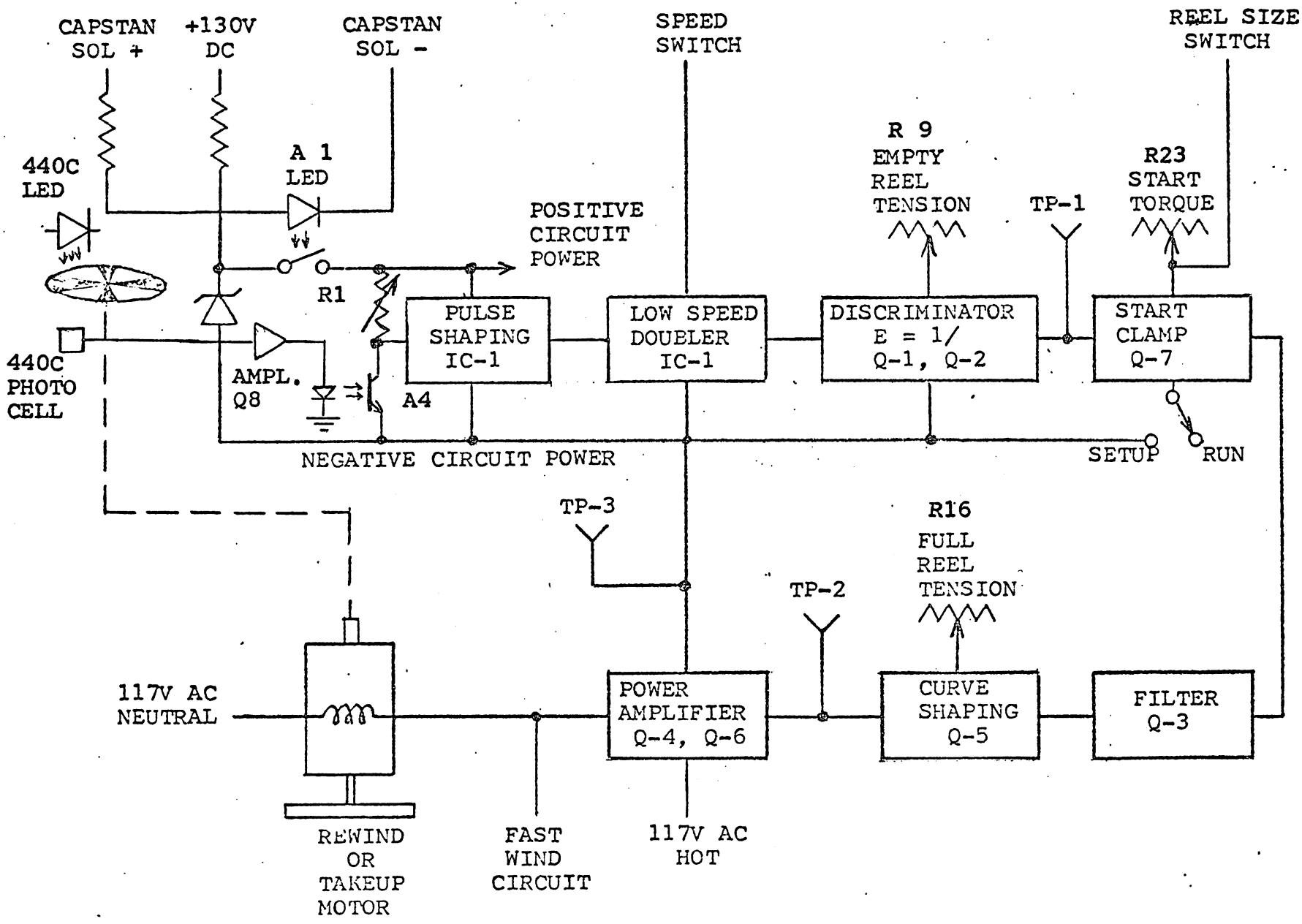
The TENTROL tension control system operates on the principle that the rotational velocity of the reel is inversely proportional to the diameter of the tape pack when the tape is traveling at a constant linear velocity. The reel velocity information is converted to a voltage which controls the power of the reel motor so that the motor torque is proportional to the reel pack diameter. Thus doubling the pack diameter will double the motor torque to produce a constant tension in the tape. Since TENTROL is an open-loop control system, there is no possibility of instability. The torque may be adjusted to produce constant tension for holdback applications, or a compromise between constant tension and constant torque for takeup applications.

Referring to the block diagram at the end of this section, the power for the control circuitry is obtained from the +130-Volt DC transport power supply, and is applied to the circuit through an optical coupler when the capstan solenoid is energized. The system is inactive in the fast winding modes, even though the circuit is still connected to the motor. The power for the motor is obtained from the AC power line and is controlled by a diode-bridge / transistor-power-amplifier controlled by a voltage developed in the control circuitry.

R1 controls the sensitivity of the photocell in the tachometer assembly to produce a square waveform from the rotating tach disc. Pulses are then formed and fed to the discriminator. In low tape speed operation, the

tachometer frequency is doubled so that the pulse frequency at a given pack diameter is the same at both tape speeds. The discriminator produces a sawtooth waveform whose voltage is inversely proportional to the reel velocity. When the tape is started, the output of the discriminator is clamped to a selectable voltage to produce an initial starting torque adjustable from zero to full motor torque. The initial starting torque will smoothly change to constant tension in approximately three seconds. Low starting torque is desirable for hold-back applications, whereas high starting torque will aide reel acceleration in takeup applications. If the transport is equipped with a reel size switch, selection of the small reel position will reduce the starting torque but have negligible effect on the controlled tension. In the Setup position of the RUN - SETUP switch, the adjusted starting torque is applied to the motor regardless of pack diameter. This is used for measuring start torque and for making tension adjustments with a spring scale. The Setup position of the switch may also be used to change the operating mode from constant tension to constant torque, as previously described.

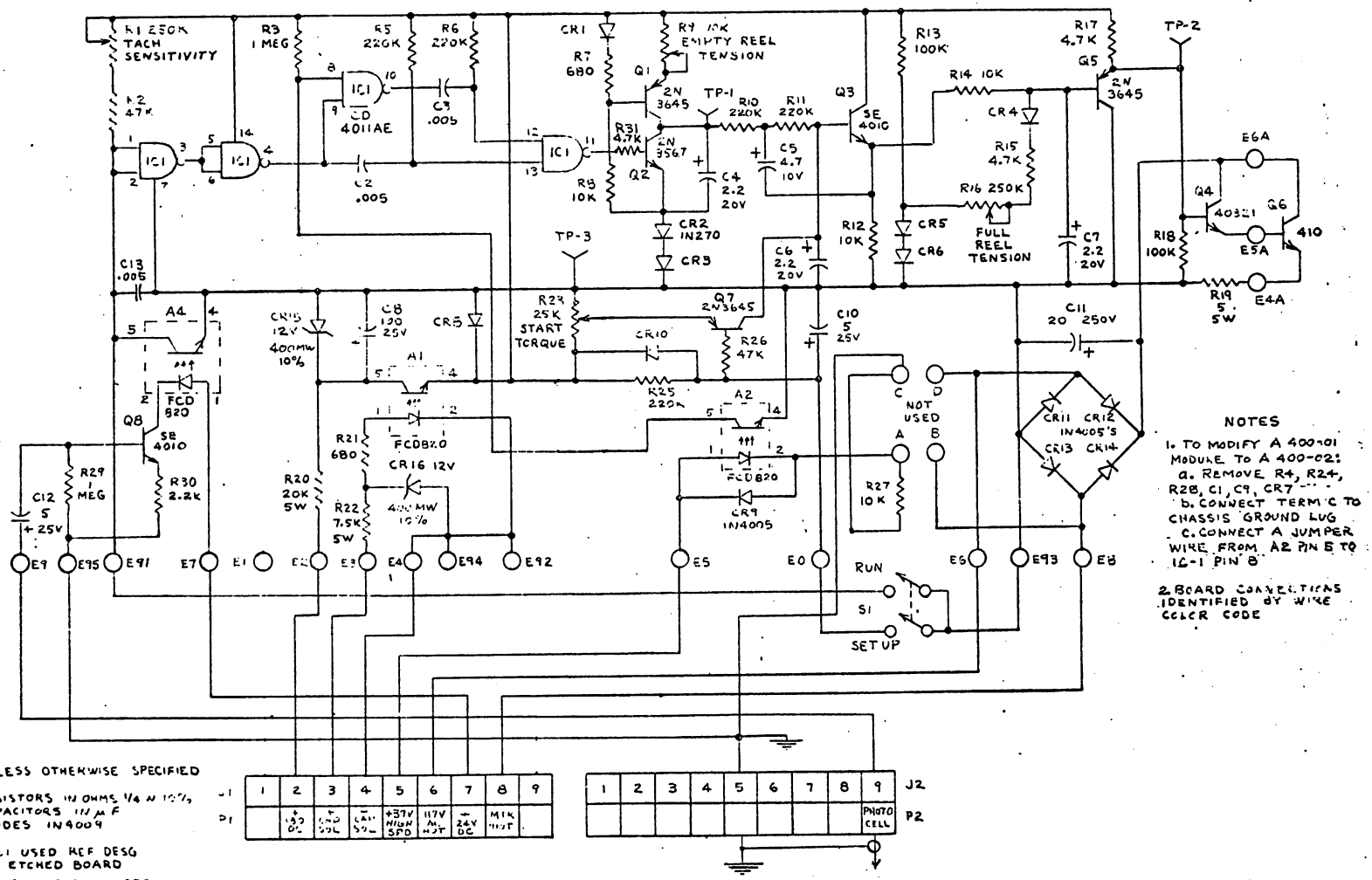
The sawtooth wave is filtered to remove the carrier frequency, and passed through an adjustable curve-shaping circuit which allows close matching of tension requirements to the motor torque characteristics. The empty reel tension control adjusts the gain of the discriminator and is used to adjust tension for the various speed pairs. The full reel tension control adjusts the degree of curve shaping to match the motor characteristics. The output of the curve shaping circuit is fed to the base of the power amplifier to control the AC voltage applied to the motor.


CAPSTAN SOL +
+130V DC
CAPSTAN SOL -
SPEED SWITCH
REEL SIZE SWITCH
440C LED
A 1 LED
R 9 EMPTY REEL TENSION
TP-1
R23 START TORQUE
POSITIVE CIRCUIT POWER
R1
PULSE SHAPING IC-1
LOW SPEED DOUBLER IC-1
DISCRIMINATOR E = 1/ Q-1, Q-2
START CLAMP Q-7
440C PHOTO CELL
AMPL. Q8
A4
NEGATIVE CIRCUIT POWER
SETUP
RUN
TP-3
R16 FULL REEL TENSION
TP-2
117V AC NEUTRAL
POWER AMPLIFIER Q-4, Q-6
CURVE SHAPING Q-5
FILTER Q-3
REWIND OR TAKEUP MOTOR
FAST WIND CIRCUIT
117V AC HOT

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	121601	PC BOARD ASS'Y (Schematic 122701)		
A 1,2, 4	1307	Optical Coupler	Fairchild	FCD 820
C 1	0867	Capacitor, 0.1 uF, 100V	Sprague	225P10491
C 2,3, 13	1064	" .005 uF, 500V Ceramic	Sprague	5GA D50
C 4,6,7	1053	" 2.2 uF, 20V Tantalum	Dickson	D2R2GSA20M
C 5	1054	" 4.7 uF, 10V Tantalum	Dickson	D4R7GSA10M
C 8	0907	" 100 uF, 25V Electrolytic	Sprague	TE 1211
C 9,10,12	0901	" 5 uF, 25V Electrolytic	Sprague	TE 1202
C 11	0913	" 20 uF, 250V Electrolytic	Sprague	TVA 1508
CR 1,3-6,8,10	1100	Diode, Silicon, 1N4009	Fairchild	
CR 2	1106	Diode, Germanium, 1N34A or 1N270		
CR 7,9,11-14	1125	Diode, Silicon rectifier, 600V, 1A	ITT	1N4005
CR 15,16	1105	Diode, Zener, 12V, 400mW, 10%	Int'l Rect	Z1014C
IC 1	1306	Integrated Circuit	RCA	CD4011AE
Q 1,5,7	1205	Transistor, PNP, 2N3645	National	
Q 2	1204	" NPN, 2N3467	National	
Q 3,8	1210	" NPN, SE4010	Fairchild	
Q 4	1216	" NPN, 40321	RCA	

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
R 1, 16	0570	Resistor, Variable, 250 k	CTS	X201R254B
R 2,26	0181	Resistor, ¼W, 10%, 47k		
R 3 ,29	0197	" " " 1 Meg		
R 4	0203	" " " 3.3 Meg		
R 5,6,10,11,25	0189	" " " 220k		
R 7,21	0159	" " " 680 ohm		
R 8,12,14,24	0173	" " " 10 k		
R 9	0510	Resistor, Variable, 10 k	Helipot	89PR10K
R 13,18	0185	Resistor, ¼W, 10%, 100k		
R 15,17 ,31	0169	" " " 4.7k		
R 19	0674	" 5W " 5 ohm	Memcore	VL5-5
R 20	0676	" " " 20k	Memcore	VL5-20K
R 22	0675	" " " 7.5k	Memcore	VL5-7.5K
R 23	0569	Resistor, Variable, 25k	CTS	X201R253B
R 27	0175	Resistor, ¼W, 10%, 15k		
TP 1,2,3	1772	Test Point	H.H. Smith	325-102
R. 28	0177	Resistor, ¼W, 10%, 22K		
R 30	0165	Resistor, ¼W, 10%, 2.2K		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	121701	CONTROL MODULE ASS'Y (Schematic 122701) Model 400-01		
	121702	CONTROL MODULE ASS'Y (Schematic 122702) Model 400-02		
J 1	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103
J 2	1676	Connector, 9-pin male shell	Molex	03-06-1091
	1678	Pin, male	Molex	02-06-2103
Q 6	1217	Transistor, NPN power	RCA	410
	2603	Insulating Cap for Q6	Jermyn	A22-2003
	2916	Vinyl Grommet	H.H. Smith	2146
	121901	INTERCONNECTING CABLES		
P 1	1676	Connector, 9-pin male shell	Molex	03-06-1091
	1678	Pin, male	Molexx	02-06-2103
P 2	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103



NOTES

1. TO MODIFY A 400-01 MODULE TO A 400-02:
   a. REMOVE R4, R24, R28, C1, C9, CR7
   b. CONNECT TERM C TO CHASSIS GROUND LUG
   c. CONNECT A JUMPER WIRE FROM A2 PIN 5 TO IC-1 PIN 8
2. BOARD CONNECTIONS IDENTIFIED BY WIRE COLOR CODE

UNLESS OTHERWISE SPECIFIED

RESISTORS IN OHMS 1/4 W 10%,
CAPACITORS IN μF
DIODES IN4009

LAST USED REF DESG ON ETCHED BOARD
A4 C13, R 6 [illegible], E90 IC1

UNUSED REF DESG
R4, R24, R28, C1, C9, CR7

SCHEMATIC DIAGRAM – "TENTROL"
Model 400-02