INSTRUCTION MANUAL

MODEL 420-01

"TENTROL"

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INOVONICS
INCORPORATED

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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. It is normally used to control the holdback tension, but in special applications may be installed on the take up motor to control take up tension.

When TENTROL is installed on the supply motor and 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 frequencey 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 420-01 Tentrol Kit consists of the following components:

1. Electronic Control Module - 6" long, 4 ½" wide, 2 ½" high.
2. Tachometer disc with adhesive backing which is installed on the brake disc.
3. Photocell Assembly with cable which mounts under existing screws on the transport brake solenoid plate.
4. Nine-wire Cable Assembly that is connected to the transport control circuitry and plugs into the TENTROL Control Module.
5. A Dummy Plug which allows bypass of TENTROL for service of the transport.

TENTROL SPECIFICATIONS

Applicable to:

Scully Models 275, 280, 280/SP-14, and 280B

Tape Widths:

150-mil Cassette; quarter-, half-, and one-inch

Reel Sizes:

"Cine" (1-7/8" hub) through 14" with NAB hub

Nominal Constant Tension at Head:

Adjustable from 3 to 9 ounces within motor torque and heat dissipation limits.*

Tension Variation Throughout Reel:

± ½ ounce

Maximum Torque Available:

85% 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.

* Motor torque is usually insufficient to produce a 9 ounce constant tension with 14 inch reels. Forced ventilation is required to reduce motor heating with tensions adjustment greater than 6 ounces (5 ounces at 3-3/4 ips).

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 Tachometer Disc Mounting

The tach disc adheres to the surface of the brake disc that faces the motor. It may be installed without removing the brake disc by removing the backing and slipping the disc around the motor shaft. The outer edge of the tach will coincide with the outer edge of the brake disc. Press it firmly to the brake disc so the cut edges of the tach disc butt.

2.2 Photocell Assembly Mounting

Loosen any two adjacent screws that hold the brake solenoid and plate assembly to the torque motor brake plate. Slip the photocell assembly bracket between the screw heads and the brake solenoid plate so that the photocell faces the tach disc. Push the photocell toward the motor centerline and tighten the two screws. The surface of the photocell should be approximately 3/32 inch (¼cm) from the surface of the tach disc. It may be adjusted by loosening the two screws that mount the photocell etched board to the photocell bracket.

2.3 Control Module Mounting

There are a number of jumper wire terminals located on the control module etched board. These are provided to adapt the control module to a wide variety of tape transports. Normally no jumpers are required with Scully transports. If your Scully has been modified so the capstan does not commence rotating until the play button is pressed, it is

advisable to jumper E1 to E2 on the etched board. This will hold a constant torque on the supply motor while the tape is coming up to speed and will smoothly change to constant tension after several seconds. To obtain access to the jumper terminals, remove the perforated metal cover from the control module.

The control module may be mounted in any convenient place where the adjustments are accessible; on the transport, console or rack. It may be mounted in any position, however, it should be remembered that the module may dissipate up to 25 watts with certain combinations of motors and tension adjustments. If high ambient temperatures are anticipated, it is recommended that the module be mounted with the heat sink fins vertical for maximum convection cooling.

2.4 Circuit Connections: 275, 280, and 280/SP-14

2.4.1 Circuit connections are made inside the relay control box and at the capstan solenoid terminal strip. Remove the control box cover. Disconnect the wire going to the swinger of S109, the holdback reel size switch. On certain models of the 280-SP/14 this is a three position switch with several sections and designated S108. Remove the wires or wire from the swinger of section A, the section whose swinger goes to K103 pin 22.

2.4.2 Connect the ends of the wires of the nine-pin cable to the following places in the transport control circuit.

CABLE COLOR	CONTOL FUNCTION	CONNECT TO
Brown	Speed	J107, Capstan Motor connector SEE SKETCH
Red	AC Neutral	J107, Capstan Motor connector SEE SKETCH

CABLE COLOR	CONTROL FUNCTION	CONNTECT TO
Orange	Cap. Sol. +	Capstan Solenoid terminal strip, terminal that goes to a 2 ohm resistor and the capstan solenoid
Yellow	Cap. Sol. -	Capstan Solenoid terminal strip, terminal that goes to a .33 mFd capacitor and the capstan solenoid
Green	Reel Size	High voltage or large reel terminal of S109, the supply reel size switch

Note: This connection is unnecessary if EIA small reel will not be used. Its only function is to reduce the starting torque when the switch is in the "small" position. This function and connection is not available in the 280-SP/14 with the three position reel size switch.

Blue	117V AC hot	Inverter Plug J104 pin 1. If there is no Inverter Plug, connect to wire that goes to J101 pin 3.
Violet Grey	Motor and Dummy Plug By-pass	Splice to the wire removed from the swinger of S109 or S108A in paragraph 2.4.1
White	Reel Size & Dummy Plug By-pass	Swinger of S109 or S108A
Black	No Connection	

2.5 Circuit Connections: 280B

2.5.1 If the 280B is equipped with a tachometer disc on the supply brake for motion sensing, it is not necessary to mount the tachometer disc supplied with the Tentrol kit. All circuit connections are made inside the transport control box and it will be necessary to drill a hole for passage of the nine-pin Tentrol interconnecting cable.

2.5.2 Disconnect the wire that goes to the swinger of the Supply Reel Tension Switch, S103 terminal 3.

2.5.3 Connect the ends of the nine-pin cable to the following places in the transport control circuit. (pg. 8A)

CABLE COLOR	CONTROL FUNCTION	CONNECT TO
Brown	Speed	Speed Switch S109 pin 5 (117V AC hot in low speed)
Red	AC Neut.	Inverter Plug J110 pin 4
Orange	+ 24V	Pinch Roller Plug J104 pin 1 or +24V tie point on chassis
Yellow	Cap. Sol. -	Pinch Roller Plug J104 pin 3 or J203 pin 6
Green	Reel Size	Supply Tension Switch S103 pin 2 (large reel end)
Blue	117V AC	Power Switch S101 pin 5 (AC hot load side)
Violet Grey }	Motor & By-pass	Splice both wires to the wire removed from the swinger of S103 in step 2.5.2
White	Reel Size & By-pass	Swinger of Supply Tension Switch S103 pin 3
Black	No Connection	

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!

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 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 begining 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. WARNING The supply motor may overheat with high tension settings, continuos operation and poor transport ventilation. If the air circulation is poor in the vicinity of the supply motor, it is recommended that the nominal tension at the head input be limited to 5 oz. at 3 3/4 ips or 6 oz. at the higher speeds. If higher tensions are needed, install a fan to circulate the air around the supply motor.

There are four adjustments associated with the Tentrol kit: Tach Sensitivity R1, Empty Reel Tension R9, Full Reel

Tension R16, and Start Torque R23. The Tach Sensitivity has been factory adjusted to match the photocell to the control module. The serial number of the control module appears on the photocell bracket. The Empty Reel Tension control affects the tension throughout the tape pack and must be readjusted should the speed pair of the transport be changed. The Full Reel Tension control will only be effective when the motor torque demand is high (full tape pack at medium tensions or at both ends of an NAB reel at tensions above 5 oz.). The Start Torque control adjusts the initial motor torque developed when entering play. It also adjusts the motor torque if the constant torque mode of operation is selected by placing the Run/Setup switch in the Setup position.

3.2 Verification of Installation

3.2.1 Install the Dummy Plug supplied for bypassing the Tentrol kit. The Dummy Plug connects to the end of the nine-pin cable attached to the transport circuitry. Check that the transports performs normally in all operating modes.

3.2.2 Connect the nine-pin cable and the tachometer cable to the Tentrol control module. Place the Run/Setup switch in Setup. The setup torque (adjusted by R23) is factory adjusted to be approximately 5 oz. measured at the NAB hub diameter. Again check that the transports functions normally in all modes.

3.3 Adjustment Using a Tension Gauge

3.3.1 Thread a 10½" or 14" reel of tape on the transport. Either speed may be selected. Make sure the tension gauge is calibrated for the tape being used. Fast wind the tape such that only ½" of tape remains on the supply reel. Make sure the Full Reel Tension control R16 is fully clockwise. Place the Run/Setup switch in Run. Start the transport in play and after the reel idler comes up to speed, insert the tension gauge between the reel idler and the head assem-

bly. Make sure the tape touches all three prongs of the gauge. If the tension gauge will not fit, remove the head assembly for this adjustment. Adjust the Empty Reel Tension control R9 for the nominal tension desired.

3.3.2 Fast wind the tape until the full pack is on the supply reel. Start the tape in play and if the tension is higher than nominal, reduce it to nominal by turning the Full Reel Tension control R16 counter clockwise. If adjusting for a nominal tension greater than 5 oz., this reduction may also reduce the tension at the end of the reel. Fast wind to the end of the reel and readjust R9. Work back and forth until optimum linearity is achieved.

3.3.3 Spot check the tensions at several places between minimum and maximum tape packs. Always make sure that tensions are measured with the reel idler coupled to the tape. Always wait at least five seconds after pressing play since it can take that long for Tentrol to change from the constant torque start to the constant tension run condition. If small EIA reels will be used, check the tension at various spots on the small reel. If the tape type is not the same on the small reel, check the calibration of the tension gauge. If tensions below 4 oz. are desired, a rising tension may be observed at the inside of the EIA reel. This can be corrected by jumpering E2 to E3 on the control module PC board. CAUTION: At very low tensions the tape may not couple to the reel idler causing erratic tension and an increase in flutter.

3.3.4 Start Torque adjustment. The starting torque cannot be stated to be optimum at a given number of ounces. It will vary with the mounting style and the spring tensions in the tape idler arms. It should be kept low to avoid capstan slippage during reel idler acceleration, but if too low, the tape will bounce off the heads during start. Five to six ounces measured with a spring scale on an NAB hub with the selector switch in Setup is a good starting point. The best method for making this adjustment is to reproduce a

pre-recorded tape and adjust R23 for the best sounding starts. Make sure to check both ends of the reel.

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 two 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 quide, 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 quide which will vary with the absolute tension, reel idler spring tension, and mounting of transport. At low absolute tensions it also varies with pack diameter.
TABLE I charts the holdback motor torque in ounces at the NAB hub diameter of 4½" for two tape pack diameters and for several nominal constant tape tensions.

TABLE I HOLDBACK MOTOR TORQUE REQUIREMENTS

PACK DIA.	NOMINAL HOLDBACK TENSION AT HEAD INPUT 4 oz.	5 oz.	6 oz.	8 oz.	
5 inch	3.5	4.5	5.5	7.5	MOTOR TORQUE IN OZ. AT NAB 4½" HUB WITH SPRING SCALE
9 inch	6.0	7.7	9.5	13.0	

3.4.2 Attach an NAB hub to the spring scale using twine and place on the supply turntable.
3.4.3 Connect a DC voltmeter to TP2 (positive) and TP3 (negative). CAUTION: THE TEST LEADS OF THIS METER WILL NOW BE AT POWER LINE POTENTIAL.
3.4.4 Place the selector switch to the Setup position. Set the Full Reel Tension control R16 to the full clockwise position.
3.4.5 Tape the tape break arm to enable the transport.
3.4.6 Using TABLE I, select the torque that corresponds with the desired nominal tension and the 5 inch pack diameter. Start the transport in play. Hold the spring scale

stationary. Adjust the Start Torque control R23 to produce this reading on the spring scale. Record the reading of the DC voltmeter.

3.4.7 Repeat this procedure, setting the torque that corresponds with the 9 inch pack diameter and record the voltmeter reading.

3.4.8 Remove the spring scale. Mark the 5" and 9" pack diameters on a full NAB reel of tape. Thread this on the transport. Place the selector switch in the Run position.

3.4.9 Fast wind to the 5" diameter mark. Start the tape in play at either tape speed. Adjust the Empty Reel Tension control R9 to give the DC voltage reading for the 5" pack.

3.4.10 Fast wind to the 9" mark. Start the tape and adjust the Full Reel Tension control R16 to give the DC voltage reading for the 9" pack.

3.4.11 When setting for 6 or 8 oz. nominal tensions, recheck the 5" pack voltmeter reading and readjust the Empty Reel Tension control R9 as required. Then recheck the 9" reading, working back and forth until the curve is matched.

3.4.12 Remove the voltmeter. Adjust the Start Torque control as described in paragraph 3.3.4.

3.5 Tachometer Sensitivity Adjustment R1

3.5.1 This is a factory adjustment that matches the photocell to the control module. It should only need readjustment when a photocell is replaced or if trouble occurs. A failure that could be the result of incorrect sensitivity adjustment would be extremely high tension unaffected by R9 yet normal operation in Setup. Extreme once around tension variation can be caused by incorrect adjustment. Ambient light entering the photocell can cause problems requiring sensitivity readjustment. The above problems can be caused by incorrect spacing between the photocell and tach disc. The tach signal will disappear if the photocell is either too close or too far away from the disc. An oscilloscope is required for this adjustment.

3.5.2 Connect an oscilloscope to TP-1 and TP-3, common to TP-3. CAUTION: MAKE SURE THAT THE 'SCOPE IS UNGROUNDED SINCE THESE TEST POINTS ARE AT POWER LINE POTENTIAL. THE 'SCOPE HOUSING MAY ALSO BE AT POWER LINE POTENTIAL AND MUST NOT BE TOUCHED SIMULTANEOUSLY WITH ANY GROUNDED OBJECT.

3.5.3 Place the Tentrol Run - Setup switch in Run. Select the low tape speed of the transport. Start the transport in the play mode.

3.5.4 Adjust R1 until a sawtooth wave appears. Fine-adjust R1 so that the amplitude of adjacent pulses are approximately equal in peak-to-peak amplitude (variation less than 20%). If this tolerance is not obtainable, try changing the photocell to disc spacing.

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. The holdback reel size switch will have no affect on the play holdback tension when operating in the Run position. It will still be active in fast wind. It also reduces the Tentrol start torque in the small reel position. 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. A ± 10% variation in line voltage will normally produce less than ½ ounce change in tension with nominal tensions of 6 ounces or less. At higher tension the absolute tension will become proportional to the line voltage change. 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 sticktion 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, two options are available. One is to bypass TENTROL by removing the nine-pin cable from the Control Module and installing the Dummy Plug in the cable connector. The other method is to change the RUN-SETUP switch to the Setup position. This will operate the transport in a constant torque mode regardless of tape speed or pack diameter. The torque desired can be adjusted with the Start Torque control, R23.

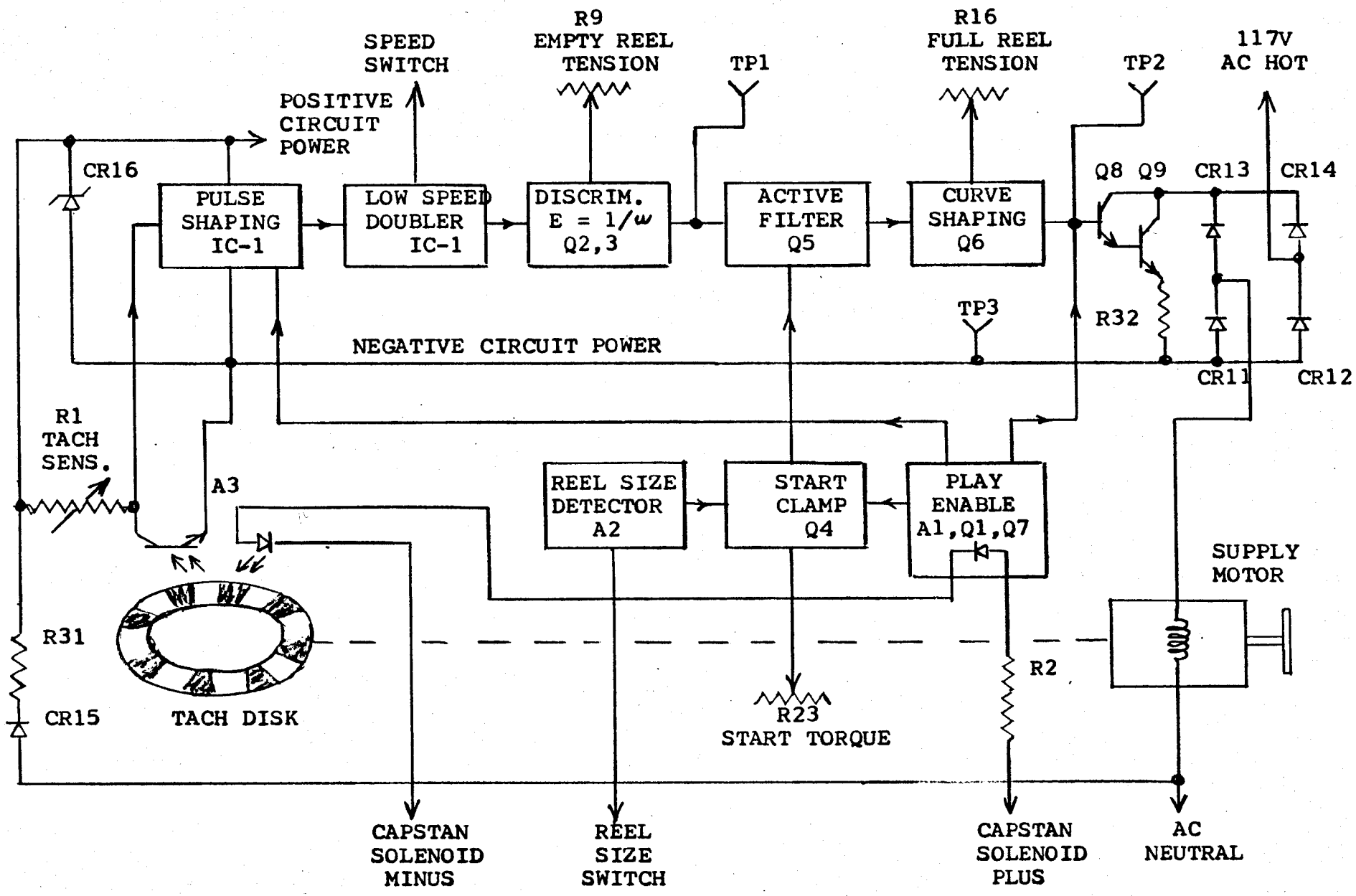
4.2 Functional Description

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 AC power line through CR15, R31, CR16, and CR12. The power amplifier Q8 and Q9 is held off by the play enable circuit and will only be activated when power is applied to the capstan solenoid. The power for the motor is obtained from the AC power line through the diode-bridge/transistor-power amplifier.

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 four seconds. Selection of the small reel position of the holdback reel size switch will reduce the starting torque but have no 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.

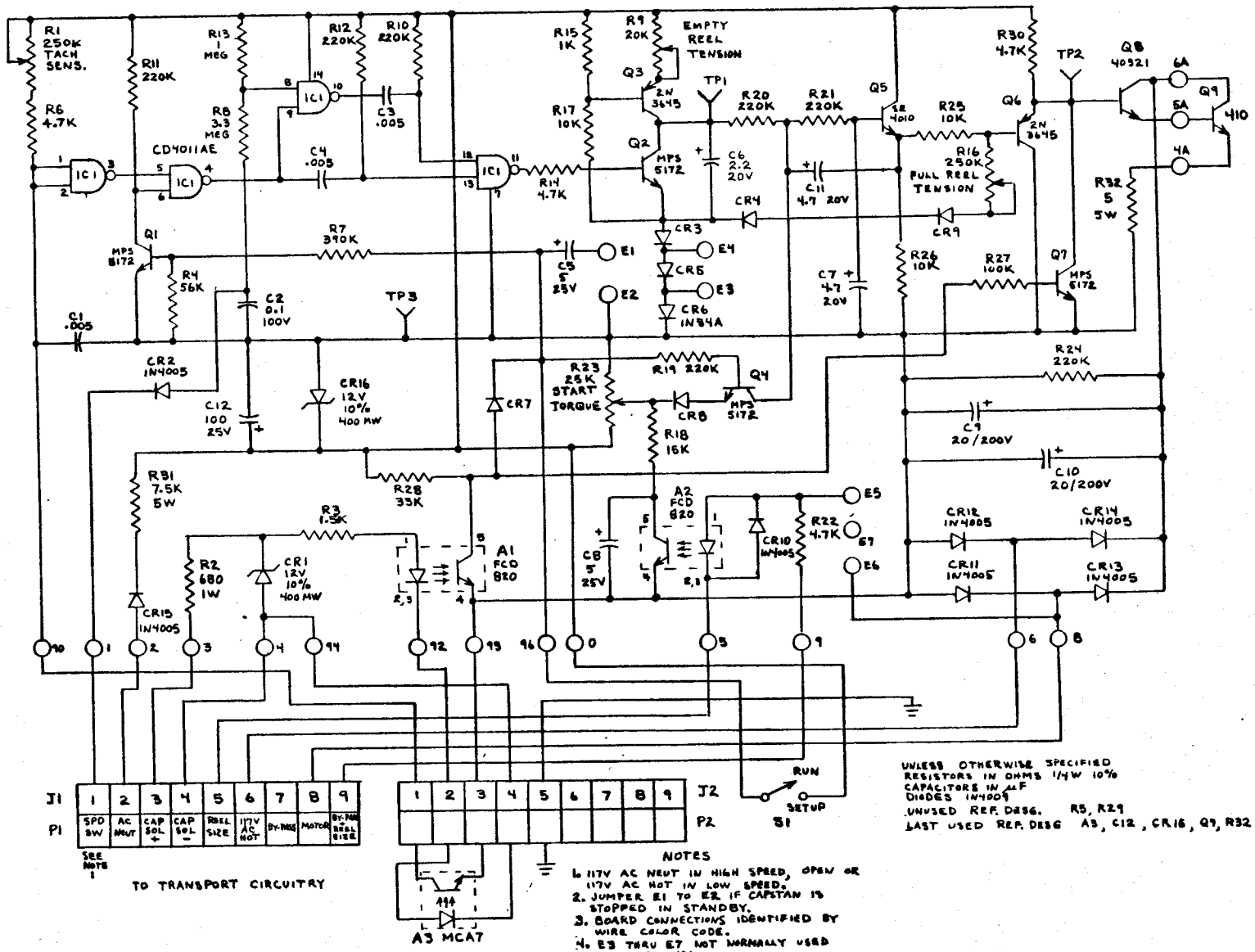
The sawtooth wave is filtered to remove the carrier frequency, and passed through an adjustable curve-shaping circuit which allows close matching of tension requirements to the motor torque characteristics. The empty reel tension control adjusts the gain of the discriminator and is used to adjust tension 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.


SPEED SWITCH
R9 EMPTY REEL TENSION
TP1
R16 FULL REEL TENSION
TP2
117V AC HOT
POSITIVE CIRCUIT POWER
CR16
PULSE SHAPING IC-1
LOW SPEED DOUBLER IC-1
DISCRIM. E = 1/ω Q2,3
ACTIVE FILTER Q5
CURVE SHAPING Q6
Q8 Q9
CR13
CR14
TP3
R32
NEGATIVE CIRCUIT POWER
CR11
CR12
R1 TACH SENS.
A3
REEL SIZE DETECTOR A2
START CLAMP Q4
PLAY ENABLE A1,Q1,Q7
SUPPLY MOTOR
R31
CR15
TACH DISK
R23 START TORQUE
R2
CAPSTAN SOLENOID MINUS
REEL SIZE SWITCH
CAPSTAN SOLENOID PLUS
AC NEUTRAL

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	129501	PC BOARD ASS'Y (Schematic 130200)		
A1,2	1307	Optical Coupler	Fairchild	FCD 820
C1,3,4	1064	Capacitor, .005 uF, 500V Ceramic	Sprague	5GA D50
C2	0867	" 0.1 uF, 100V Mylar	Sprague	225P10491
C5,8	0901	" 5 uF, 25V Electrolytic	Sprague	TE 1202
C6	1053	" 2.2 uF 20V Tantalum	Matsuo	DTSA12002225M
C7,11	1054	" 4.7 uF 20V Tantalum	Matsuo	DTSA22002475M
C9,10	0916	" 20 uF 200V Electrolytic	Sprague	TE 1442.1
C12	0907	" 100 uF 25V Electrolytic	Sprague	TE 1211
CR1,16	1105	Diode, Zener 12V, 400mw, 10%		1N5242
CR2,10-15	1125	Diode, Silicon, 600V, 1A		1N4005
CR3-5,7-9	1100	Diode, Silicon		1N4009
CR6	1106	Diode, Germanium		1N34A or 1N270
IC1	1306	Integrated Circuit, C-MOS	RCA	CD4011AE
Q1,2,4,7	1219	Transistor, NPN, MPS5172	MOtorola	
Q3,6	1205	" PNP, 2N3645	National	
Q5	1210	" NPN, SE4010	Fairchild	
Q8	1216	" NPN, 40321	RCA	
R1,16	0570	Resistor, Variable, 250K	CTS	X201R254B
R2	0425	" 1W, 10% 680 ohm		
R3	0163	" ¼W, 10% 1.5K		
R4	0182	" " 56K		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
R6,14,22,30	0169	Resistor, ¼W 10% 4.7K		
R7	0192	" " 390K		
R8	0203	" " 3.3 Meg		
R9	0511	" Variable, 20K	Beckman/Hel	89PR20K
R10-12,19-21, 24	0189	" ¼W 10% 220K		
R13	0197	" " 1 Meg		
R15	0161	" " 1K		
R23	0569	" Variable, 25K	CTS	X201R253B
R17,25,26	0173	" ¼W 10% 10K		
R18	0175	" " 15K		
R27	0185	" " 100K		
R28	0179	" " 33K		
R31	0675	" 5W 10% 7.5K		
R32	0674	" " 5 ohm		
TP1,2,3	1772	Test Point	H.H.Smith	325-102 Red
	129601	CONTROL MODULE ASS'Y (Schematic 130200)		
J1	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103
J2	1676	Connector, 9-pin male shell	Molex	03-06-1091
	1678	Pin, male	Molex	02-06-2103
Q9	1217	Transistor, NPN power	RCA	410
	2603	Insulating Cap for Q9	Jermyn	A22-2003

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
S1	1816	Switch, SPDT Slide	H.H.Smith	516
	129700	PHOTOCELL ASS'Y (Schematic 130200)		
	125400	Etched Board		
A3	1309	Optical Coupler	Monsanto	MCA7
P2	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103
	121900	NINE PIN CABLE ASS'Y		
P1	1676	Connector, 9-pin male shell	Molex	03-06-1091
	1678	Pin, male	Molex	02-06-2103
	126400	TACH DISC ASS'Y		
	130000	DUMMY PLUG ASS'Y		
	1675	Connector, 9-pin female shell	Molex	03-06-2091
	1677	Pin, female	Molex	02-06-1103



NOTES

1. 117V AC NEUT IN HIGH SPEED, OPEN OR 117V AC HOT IN LOW SPEED.
2. JUMPER E1 TO E2 IF CAPSTAN IS STOPPED IN STANDBY.
3. BOARD CONNECTIONS IDENTIFIED BY WIRE COLOR CODE.
4. E3 THRU E7 NOT NORMALLY USED IN MODEL 420.

UNLESS OTHERWISE SPECIFIED
RESISTORS IN OHMS 1/4W 10%
CAPACITORS IN μF
DIODES IN4004
UNUSED REF. DESG. R5, R29
LAST USED REF. DESG A3, C12, CR16, Q9, R32

SCHEMATIC DIAGRAM - "TENTROL"

Model 420-01

INOVONICS WARRANTY

Inovonics, Inc. products are warranted to be free from defects in material and workmanship. Any discrepancies noted within 90 days of the date of purchase will be repaired free of charge. Additionally, parts for repairs required between 90 days and one year from the date of purchase will be supplied free of charge, with installation billed at normal rates. It will be the responsibility of the purchaser to return equipment for warranty service to the dealer from whom it was originally purchased unless prior arrangement is made with the dealer to inspect or repair at the user's location.

This warranty is subject to the following conditions:

1. Warranty card supplied with the equipment must be completed and returned to the factory within 10 days of purchase.

2. Warranty is void if unauthorized attempts at repair or modification have been made, or if serial identification has been defaced, removed, or altered.

3. Warranty does not apply to damage caused by misuse, abuse, or accident.

4. Warranty valid only to original purchaser.

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