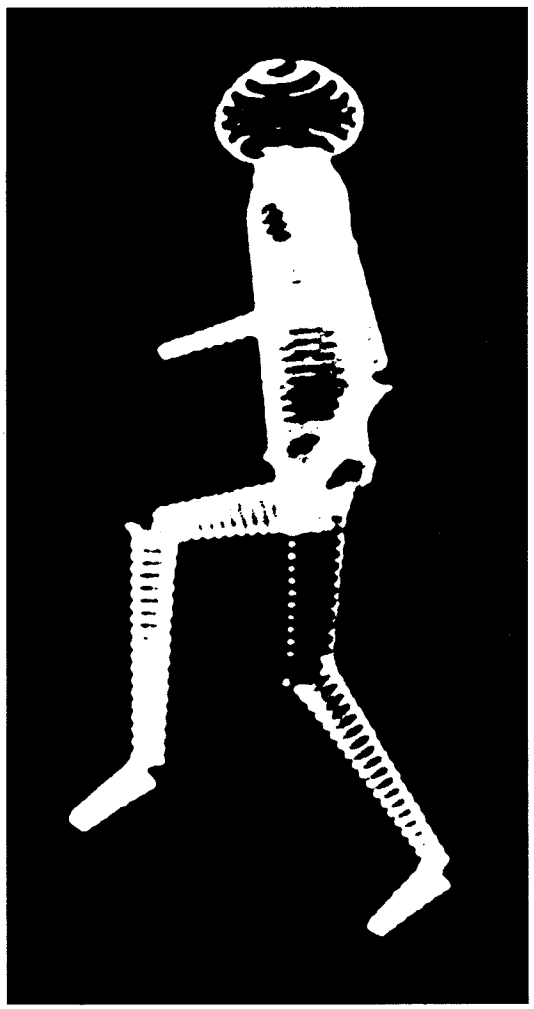
NOTES FOR AN EARLY ANIMATION DEVICE

Lee Harrison

The following paper is reprinted in facsimile form as the most primary and authentic source of Lee Harrison's original concept for electronic animation. These notes eventually materialized as the ANIMAC animation system. —D.D.



Witnessed by [signature] 12/29/61

... TODAY IS DEC. 29, 1961 [signature] N.A.C., 44

THE CLOCK OR MASTER OSCILLATOR, IS A STABLE, VARIABLE-FREQUENCY WAVEFORM GENERATOR

~~THE OUTPUT OF THE CLOCK~~

THERE ARE TWO SIGNAL OUTPUTS OF THE CLOCK OR MASTER OSCILLATOR. ONE IS A SQUARE WAVE ⊓⊔, THE OTHER, A SINE WAVE. ∿. THE OUTPUTS ARE AT THE EXACT SAME FREQUENCY.

THE FUNCTION OF THE CLOCK IS TO FURNISH THE "DRIVING-SIGNALS" TO THE DEVICE. IT IS ALSO A MEANS BY WHICH THE INNER WORKINGS OF THE DEVICE ARE "TIME-SYNCHRONIZED."

WE REFER TO THE OUTPUT OF THE CLOCK AS "HIGH FREQUENCY," BECAUSE WE COUNT DOWN (BY MEANS OF A COUNTER TO BE DESCRIBED LATER) TO THE "FRAME FREQUENCY", THUS ESTABLISHING A FRAME RATE. FRAME RATE IS THE RATE AT WHICH WE DRAW ONE COMPLETE FIGURE OR PICTURE ON THE DISPLAY SCOPE.

BECAUSE THE COUNTER PERFORMS A FIXED-RATIO COUNTDOWN, THE LOW FREQUENCY IS ALWAYS A LOWER MULTIPLE OF THE HIGH FREQUENCY.

THUS, BY VARYING THE HIGH FREQUENCY, WE AUTOMATICALLY VARY THE LOW FREQUENCY OR FRAME RATE.

DURING THIS DEVELOPEMENTAL PERIOD, WE ARE OPERATING AT FRAME RATES BETWEEN 24 AND 30 CYCLES PER SECOND (CPS). 30 cps IS DESIRABLE AT THIS TIME BECAUSE

a.) THE LIGHTING IN OUR WORKSHOP IS SUCH THAT AT A LOWER FRAME RATE, WE SEE A BOTHERSOME FLICKER, and

b). IT IS VERY EASY TO SYNCHRONIZE THE FREQUENCIES TO "60-CYCLE LINE FREQUENCY" (JUST TWICE THE FRAME RATE) WITH A HAND ADJUSTMENT AND THEREBY ELIMINATE WHAT IS KNOWN AS "HUM" OR LINE NOISE, WHICH IF NOT SYNCHRONIZED CAUSES A SLOW WOBBLE OF THE PICTURE.

IN THE FUTURE, WE WILL INSTALL A FEEDBACK TIMING CONTROL IN THE COUNTER CIRCUIT WHICH WILL AUTOMATICALLY SYNCHRONIZE ALL FREQUENCIES TO THE LINE (60CPS) AND

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[signature]

THUS ELIMINATE THE NECCESSITY OF HAND ADJUSTMENTS AND ALSO ASSURE AN EXACT 24 CPS FRAME RATE.

THE SQUARE WAVE OUTPUT IS FED DIRECTLY INTO THE COUNTER. IT IS ALSO FED INTO AND IS THE DRIVING SIGNAL FOR THE HORIZONAL DEFLECTION GENERATOR OF THE SKIN SCANNER (TO BE DECRIBED LATER.)

THE SINE WAVE OUTPUT IS FED INTO TWO OF THE SAMPLERS (SAMPLER GATES) TO BE DESCRIBED LATER, ALSO INTO A 90 DEGREE PHASE SHIFTER WHOSE OUTPUT NOW BECOMES A COSINE WAVE (IN RELATION TO THE ORIGINAL SINE WAVE) WHICH IS SUBSEQUENTLY FED INTO THE OTHER SET OF SAMPLERS. ALSO BOTH SINE AND COSINE WAVES ARE FED INTO MODULATORS (TO BE DECRIBED LATER)

THE FUNCTION OF THE CLOCK MAY BE TAKEN OVER BY THE TAPE RECORDER, WHERE THE CLOCK SIGNALS ARE RECORDED ON ONE OF THE CHANNELS, AND USED AS DRIVING SIGNALS OF THE DEVICE, THUS SYNCHRONIZING ALL RECORDED SIGNALS WITH THE "TAPE CLOCK".

COUNTER & TIMING CONTROL

THE COUNTER IS A CHAIN OF BISTABLE MULTIVIBRATORS. THE INPUT TO THE FIRST BSMV IN THE CHAIN IS THE HIGH FREQUENCY SQUARE WAVE FROM THE CLOCK. THE OUTPUT OF THE FIRST BSMV IS A SQUARE WAVE WHICH IS EXACTLY ½ THE FREQUENCY OF THE INPUT. THUS EACH BSMV IN THE CHAIN HALVES ITS INPUT FREQUENCY.

AT THE PRESENT TIME WE HAVE 9 BSMV'S IN THE COUNTER CHAIN. THIS GIVES A COUNTDOWN RATIO OF 512:1. THUS FOR A FRAME RATE OF 24 FRAMES/SEC, THE HIGH FREQUENCY MUST BE 12,288 CPS

THERE IS NOTHING MAGIC ABOUT THIS SELECTED RATIO OF 512 TO 1. THE CHOISE OF IT AT THIS TIME WAS GOVERNED BY THE EASE WITH WHICH WE ARE ABLE TO USE THE HIGH FREQUENCY IN THE FUNCTION (SINE-COSINE) GENERATOR NETWORK. IF THE FREQUENCIES USED IN THAT NETWORK GET TOO HIGH, THE GENERATOR DOES NOT PERFORM AS WELL AS WE'D LIKE IT TO. WE HAVE NOT HAD TIME TO REDESIGN THE NETWORK. HOWEVER IT WORKS WELL UP TO 16 OR 17 KC. EASILY ALLOWING A 30 FPS FRAME RATE.

OF COURSE, THE HIGHER THE FREQUENCY WE USE, THE GREATER "BONE & SKIN" RESOLUTION WE MAY HAVE (THIS WILL BE EXPLAINED LATER.)

THE OUTPUT OF THE FIRST BSMV, BESIDES BEING FED INTO THE 2nd BSMV, IS ALSO FED INTO THE DELAY MULTIVIBRATORS IN THE AFORE-MENTION SINE-COSINE FUNTION GENERATOR NETWORK, AND ACTS AS A DRIVING SIGNAL FOR THOSE DELAY MV'S. IN OTHERWORDS, IT CAUSES THE DELAY MV'S TO ALSO, A SAMPLING OF THE SINE-AND COSINE WAVES IN THE SAMPLERS AT ½ THE FREQUENCY OF THE SINE & COSINE WAVES IN THE SAMPLERS, AS THERE ARE 2 CYCLES TO SAMPLE FROM.

(1 COUNTER, WILL AVERAGE 8 CPS (AS ACCURATELY AS THE LINE FREQUENCY IS 60 CPS) AT THE BACK END OF THE COUNTER. FOR USE WITH A TIME ADJUSTED BY A MOTOR SPEED GOVERNOR, WHICH WOULD ACCURATELY & ACCURATE THE TIME SPEED AND PHASE THE FREQUENCIES COMING OFF THE DRIVE.

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THE SIGNIFICANCE OF THIS IS THAT WE CAN GET MORE THAN A 360° ROTATION OF A BONE. (TO BE DESCRIBED MORE FULLY)

THE TIMING CONTROL IS A FEEDBACK NETWORK WHICH AUTOMATICALLY SYNCHRONIZES ALL OF THE DRIVING FREQUENCIES (i.e. HIGH & LOW) TO THE 60 CPS LINE-FREQUENCY, THUS ASSURING AN EXACT 24 FPS FRAME RATE.

HUM: THE ELECTRONIC EQUIPMENT OPERATES BY POWER RECIEVED FROM A 60 CYCLE SUPPLY LINE. THIS POWER AT 60CPS IS PRESENT IN WIRES AND CABLES NEAR & THRU THE EQUIPMENT, AND HAS A TENDENCY TO RADIATE A CERTAIN AMOUNT OF THIS POWER TO ADJACENT PARTS. THE RESULT IS THAT THERE IS ALWAYS PRESENT A SLIGHT VOLTAGE RIPPLE ON THE LINES, IN THE AMPLIFIERS, AND EVEN IN THE D.C. REGULATED-VOLTAGE SUPPLIES. THIS MAY BE ELIMINATED BY SHIELDING AND FILTERING OF THE SUPPLIES, OR IT MAY BE COMPENSATED FOR BY SYNCHRONIZING ALL OF THE FREQUENCIES TO THIS HUM. FOR EXAMPLE, LET US SUPPOSE WE ARE OPERATING AT 23.999 FRAMES PER SECOND, AND THE LINE RIPPLE IS AT 60 CPS. THE PICTURE WILL TEND TO SLOWLY UNDULATE BECAUSE OF A BEAT SET UP BY THE TWO, NON-MULTIPLE FREQUENCIES, HOWEVER, BY MAKING THE FRAME RATE EXACTLY 30 FPS, WE WILL DRAW 5 COMPLETE FRAMES FOR EVERY 6 CYCLES OF HUM.

THERE ARE 2 INPUTS TO THE TIMING CONTROL: ONE IS THE 24 CPS FROM THE COUNTER, THE OTHER IS 60 CPS FROM THE LINE. THE 24 CPS FRAME RATE IS FED INTO A BSMV WHOSE OUTPUT IS THEREFORE 12 CPS. THE LINE FREQUENCY (60CPS) IS FED INTO A 5:1 COUNTER (BINARY FEEDBACK TYPE) AND ITS OUTPUT IS 12 CPS. THESE 2 FREQUENCIES ARE THEN FED INTO A PHASE-COMPARATOR. THE OUTPUT OF THE PHASE-COMPARITOR (A D.C. VOLTAGE) IS FED INTO A D.C.-CONTROLLED OSCILLATOR WHOSE MEAN OUTPUT FREQUENCY WILL BE THE DESIRED HIGH FREQUENCY WHICH WHEN FED INTO THE FRONT END OF THE

ELECTRONIC GATE-COMMUTATOR OR MONOSTABLE MULTIVIBRATOR CHAIN

THE CHAIN OF MONOSTABLE MULTIVIBRATORS (MSMV) IS AN ELECTRONIC COMMUTATOR WHICH OPENS AND CLOSES A SERIES OF "BONE" GATES IN A SEQUENTIAL MANNER. IN OTHER WORDS, THE MSMV'S FURNISH THE DRIVING (OPENING & CLOSING) SIGNALS TO THE GATES.

THE INPUT TO THE FIRST MSMV IN THE CHAIN IS A FRAME-RATE FREQUENCY PULSE (SAY 24 CPS) WHICH COMES FROM THE COUNTER. WHEN THE PULSE ARRIVES, IT CAUSES THE MSMV TO FLIP INTO ITS OTHER (UNSTABLE) STATE, FOR A LENGTH OF TIME AS DETERMINED BY ITS INTEGRAL RC NETWORK. BY VARYING R, THE LENGTH OF TIME DURING WHICH THE MSMV IS IN ITS UNSTABLE STATE MAY BE VARIED. ~~WHEN THIS TIME HAS LAPSED, THE~~ DURING THIS "OPEN" TIME, A CHANGE IN VOLTAGE OCCURS ON ONE OF ITS OUTPUTS. THIS VOLTAGE IS USED TO OPEN A NUMBER OF GATES CONNECTED TO IT. WHEN THE "OPEN" TIME HAS LAPSED, THE MSMV AUTOMATICALLY FLIPS BACK INTO ITS ORIGINAL STATE (STABLE) AND CHANGES BACK THE OUTPUT VOLTAGE DRIVING THE GATES, THUS CLOSING THEM. DURING THE FLIP-BACK, A PULSE SIMILAR TO THE ONE THAT CAUSED THE ORIGINAL FLIP IS GENERATED AT ANOTHER OUTPUT POINT, AND THENCE IS SENT TO THE NEXT MSMV IN THE CHAIN WHERE A SIMILAR OPERATION OCCURS, THUS OPENING THE NEXT GROUP OF ASSOCIATED GATES FOR A TIME DESCRIBED BY THE R ASSOCIATED WITH THAT 2ND MSMV. THIS COMMUTATING ACTION CONTINUES UNTIL ALL THE MSMV'S IN THE CHAIN HAVE GONE THRU THEIR INDIVIDUAL CYCLES.

THE "DRIVING OUTPUT" OF THE MSMV'S (SHOWN IN FIG 1.) IS USE TO PERFORM A NUMBER OF TASKS. FOR EXAMPLE, THIS OUTPUT MAY BE USED TO CLOSE THE ELECTRONIK SWITCHES ACROSS THE

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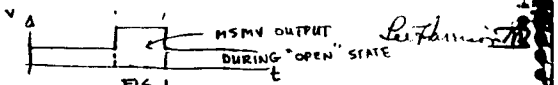

FIG 1

INTEGRATING CAPACITORS, THUS CAUSING THE DISPLAY BEAM TO "FLY BACK" TO ITS STARTING POINT. THESE SIGNALS ARE USED THEREFORE AS INPUTS TO THE FLYBACK CIRCUIT, TO BE DESCRIBED LATER IN MORE DETAIL. ANOTHER USE OF THE MSMV OUTPUT IS TO DIM OR BLANK-OUT THE DISPLAY BEAM. BY APPLYING THE MSMV OUTPUT TO THE GRID OF THE DISPLAY CRT, THE BEAM IS "TURNED-OFF" DURING THE "OPEN" TIME OF THE MSMV SO ENGAGED. IN THIS MANNER, FLYBACK RETRACES, AND CERTAIN BONE-PLACING RETRACES - (AS IN THE ARMS, WHERE THE BEAM MUST MOVE FROM THE STARTING POINT, UP TO THE SHOULDER AND THENCE PROCEDE TO DRAW THE ARM, AND DURING THAT "PLACEMENT" BONE DRAWING, THE BEAM IS BLANKED OUT) MAY BE BLANKED OUT AS DESIRED.

AS MENTIONED BEFORE, THE LENGTH OF TIME THAT AN MSMV REMAINS IN ITS OPEN POSITION IS DETERMINED BY R OF THE INTEGRAL RC. NETWORK. THUS BY VARYING EACH OF THE RESISTANCES ASSOCIATED WITH EACH MSMV-RC-NETWORK, AN OPERATOR IS ABLE TO "SET-UP" A FIGURE OR CHARACTER TO HAVE THE DESIRE "BONE" LENGTHS, AND OVERALL STRUCTURE. HE ALSO, IN THIS BETUP PROCEDURE, DETERMINES THE SEQUENCE IN WHICH THE PARTICULAR BONES WILL BE DRAWN. IN DETERMINING THIS SEQUENCE HE MAKES THE NECCESSARY CONNECTIONS BETWEEN THE MSMV'S AND THE FLYBACK AND BLANKING CIRCUIT IN ADDITION TO DETERMINING AND SETTING UP THE DESIRED BONE LENGTHS.

THE MSMV CHAIN IS A SWITCHING, COMMUTATING NETWORK WHICH REGULATES THE OPENING AND CLOSING OF THE "BONE" GATES, THE VARIOUS TASKS WHICH IT PERFORMS COULD BE DONE IN OTHER WAYS, SUCH AS (a) MECHANICAL SYSTEMS; (b.) BINARY COUNTER SYSTEMS WITH AND/OR DIODE NETWORKS c.) OTHER ELECTRONIC ARRANGEMENTS d.) electro-MECHANICAL SYSTEMS.

BONE GATES.

ASSOCIATED WITH EACH BONE, AND BEING DRIVEN BY A MSMV OF THE MSMV CHAIN, ARE A NUMBER OF ELECTRONIC GATES. THESE GATES ARE NORMALLY CLOSED, BUT ARE OPENED BY THE RECTANGULAR WAVE FORM RECEIVED FROM THEIR DRIVING MULTIVIBRATOR. THERE IS AN OUTPUT FROM THE GATE ONLY DURING THE "OPEN" PERIOD, AND THE NATURE OR CHARACTER OF THIS OUTPUT ~~IS A FAITHFUL REPRODUCTION OF THE~~ GOVERNED BY THE INPUT SIGNAL. IF THE INPUT IS A D.C. SIGNAL, THEN THE OUTPUT WILL BE A CORRESPONDING D.C SIGNAL, (SIMILARLY IF THE INPUT IS A SINE WAVE OR OTHER SHAPED SIGNAL, THE OUTPUT WILL LOOK LIKE THE INPUT.) IN OTHER WORDS, THE GATE PASSES OR ALLOWS TO PASS THRU IT ANY SIGNAL THAT IS PRESENT AT ITS INPUT DURING THE "OPEN-PERIOD" OF THE GATE.

THE GATES FOR EACH BONE ARE IN PARALLEL, AND OPERATE SIMULTANEOUSLY, AND SEND SIGNALS TO DIFFERENT PARTS OF THE DEVICE IN ORDER TO "MAKE" BONES AND CONTROL THEIR RECORDED POSITIONS IN SPACE. A GATED D.C WAVEFORM (AS WILL BE SHOWN LATER) MAKES A STRAIGHT BONE. A GATED "SHAPED" WAVEFORM WILL MAKE A BONE WHOSE AXIS IS NOT STRAIGHT, BUT HAS THE INTEGRATED, VECTORIAL DIRECTION (OR SHAPE) PRESCRIBED BY THE SHAPED INPUT.

BY VARYING THE D.C. VOLTAGE APPLIED TO THE FIRST GATE, THE ANGLE (Θ) THAT THE BONE MAKES WITH THE X-AXIS OF THE DISPLAY IS VARIED. A VARIABLE POTENTIOMETER MAY BE USED TO VARY THE INPUT VOLTAGE, (OTHER MEANS MAY BE USED, OF COURSE). THE SECOND GATE IS USED TO CONTROL THE ANGLE THAT THE BONE MAKES WITH THE X-Y PLANE, IN SIMILAR FASHION

BY VARYING THAT D.C. INPUT. THE THIRD GATE IS USED TO CONTROL THE ANGULAR POSITION (OR MAY BE CALLED "ROTATIONAL POSITION") OF THE SKIN ON THE BONE.

ADDITIONAL GATES MAY BE USED IN SIMILAR FASHION TO CONTROL OTHER PARAMETERS OF THE BONE - SUCH AS INTENSITY, ETC, TEXTURE ETC.

THE FIRST TWO GATES CALLED "Θ" AND "ϕ" SEND THEIR OUTPUT SIGNALS TO SIMILAR, ANGLE-PRODUCING NETWORKS. THESE SIGNALS MAY ALSO BE SENT TO CORRESPONDING CHANNELS OF THE TAPE RECORDER, SO THAT DURING PLAYBACK THESE MULTIPLEXED SIGNALS WILL DRIVE THE BONE AND SKIN PRODUCING MECHANISMS OF THE DEVICE, THUS AUTOMATICALLY PRODUCING THE PREVIOUSLY RECORDED MOVEMENTS OF THE BONES & ASSOCIATED PARTS.

THE OUTPUTS OF CONSECUTIVE Θ GATES ARE ALL FED INTO THE "Θ" - SINE-COSINE FUNCTION-GENERATOR AND SIMILARLY THE OUTPUTS OF ϕ GATES INTO THE ϕ SINE COSINE FUNCTION GEN.

[illegible] - COSINE FUNCTION GENERATOR

Lee Harrison III

THERE ARE 2 SINE-COSINE FUNCTION GENERATORS. ONE RECEIVES ITS INPUT FROM THE ⊖-GATES, THE OTHER FROM THE ϕ GATES. EACH GENERATOR HAS 2 OUTPUTS FOR EACH INPUT. THE RANGE OF VOLTAGES AT THE INPUT REPRESENT ANY DESIRED ANGULAR POSITION OF THE BONE, AND THE TWO VOLTAGE OUTPUTS HAVE THE RELATION OF THE SINE AND COSINE RESPECTIVELY (SEE GENERAL THEORY)

IN ORDER TO PRODUCE THE RELATIVE VALUES OF THE SINE AND COSINE, SAMPLES OF SINE AND COSINE WAVES ARE TAKEN AT REGULAR INTERVALS, AND THESE SAMPLES ARE FED INTO CAPACITORS WHICH HOLD THE SAMPLED VOLTAGES TO PRODUCE D.C. VOLTAGES ACROSS THE CAPACITORS WHICH ARE AT THE LEVELS BEING SAMPLED.

A SINE-COSINE FUNCTION GENERATOR HAS IN ITS NETWORK A DELAY MULTIVIBRATOR, A NARROW-OUTPUT MONOSTABLE MULTIVIBRATOR, 2 WAVE-SAMPLING GATES AND A HOLDING CAPACITOR ON THE OUTPUT OF EACH SAMPLING GATE. THE DELAY MULTIVIBRATOR HAS TWO INPUTS. ONE INPUT COMES FROM THE 2nd STAGE OF THE COUNTER, AT ½ THE HIGH FREQUENCY AND IS OF THE SQUARE WAVE TYPE. THIS INPUT CAUSES THE DELAY M.V. TO CHANGE STATES, IT WILL REMAIN IN THIS STATE UNTIL IT FLIPS BACK AUTOMATICALLY INTO ITS ORIGINAL STATE. THE LENGTH OF TIME THAT IT REMAINS IN THE UNSTABLE STATE IS DETERMINED BY THE 2ND INPUT. THIS 2ND INPUT (WHICH COMES FROM THE GATES) IS A D.C. VOLTAGE WHOSE VALUE DETERMINES THE LENGTH OF TIME THE DELAY M.V. WILL DELAY.

THE DRIVING INPUT TO THE SINE-COSINE FUNCTION GENERATOR IS AT A VERY HIGH FREQUENCY. THIS MEANS THAT THE DELAY M.V. PERFORMS ITS FUNCTION ONCE FOR EVERY 2-3 CYCLES OF THE HIGH FREQUENCY. THIS ALLOWS A SAMPLING OF INTO SINE & COSINE VALUES TO BE TAKEN OVER 2 CYCLES OF THE WAVES, WHICH ALLOWS FOR A ONE-ANGLE SWING OF MORE THAN 360° OPERATIONS.

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THE OUTPUT OF THE DELAY M.V. IS DIFFERENTIATED AND CLIPPED, SO THAT ONLY A NARROW PULSE REPRESENTING THE TRAILING EDGE OF THE CHANGE-OF-STATES IS SENT ON TO THE NARROW-PULSE MSMV.

THE INPUT TO THE NARROW PULSE MSMV IS A NARROW, TRIGGER PULSE COMING FROM THE DELAY MV. THE OUTPUT OF THE MSMV IS A VERY NARROW, STRAIGHT SIDED PULSE WHICH IS USED TO DRIVE (OR OPEN) 2 SAMPLING GATES. THE GATES ARE VERY FAST ACTING. ANOTHER INPUT TO THE GATES IS A SINE WAVE (TO ONE) AND A COSINE WAVE (TO THE OTHER) COMING FROM THE SINEWAVE GENERATOR (CLOCK) AND FROM THE PHASE-SHIFTER RESPECTIVELY, THUS THE OUTPUT OF THE GATES IS A VERY NARROW PULSE WHOSE HEIGHT (OR VALUE OF VOLTAGE) IS DETERMINED BY THE TIME AT WHICH THE SINE AND COSINE WAVES WERE SAMPLED, WHICH TIME WAS DETERMINED BY THE TRAILING EDGE OF THE DELAY M.V., WHICH TIME WAS DETERMINED BY THE D.C. VOLTAGE IMPRESSED UPON IT, THIS VOLTAGE HAVING BEEN DETERMINED BY THE OUTPUT OF THE BONE GATES. THE NUMBER OF SUCH PULSES FOR ANY GIVEN D.C. VALUE IMPRESSED UPON THE DELAY M.V. IS DETERMINED BY THE LENGTH OF ANY GIVEN BONE.

BECAUSE OF THE HOLDING CAPACITOR ASSOCIATED WITH THE OUTPUT OF EACH SAMPLING GATE, THERE APPEARS ACROSS EACH CAPACITOR A D.C. VOLTAGE REPRESENTING A PARTICULAR VALUE OF SINE OR COSINE. FOR A NORMAL-LENGTH BONE, THE HOLDING CAPACITOR MAY RECEIVE 15 OR 20 SAMPLING PULSES DURING THE TIME THE BONE IS BEING GENERATED.

THERE ARE OTHER WAYS OF GENERATING THIS SINE-COSINE FUNCTION, ONE SIMPLE WAY WOULD BE TO LET THE OUTPUT OF THE BONE GATES SUPPLY VOLTAGE TO ASSOCIATED SINE-COSINE POTENTIOMETERS BUT THESE POTS ARE EXPENSIVE AND

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* IT WOULD BE REQUIRED THAT TWO BE GIVE FOR EACH GATE, CONTROLLING INPUTS WOULD NEED EXTERNAL MECHANICAL.

...NE INTEGRATORS

THE INTEGRATOR IS A HIGH GAIN AMPLIFIER WHICH HAS A FEEDBACK CAPACITOR TO ITS INPUT. ITS FUNCTION IS TO PERFORM CONTINUOUS INTEGRATION of THE SIGNALS PRESENTED TO ITS INPUT. THERE ARE THREE INTEGRATORS IN THE BONE GENERATOR, ONE FOR EACH COORDINATE (ie X, Y, Z) OF [illegible].

IF THE INPUT TO AN INTEGRATOR IS A D.C. VOLTAGE, THE OUTPUT IS A RAMP FUNCTION. THE INITIAL CONDITIONS (STARTING VOLTAGES ON THE OUTPUT WHICH DETERMINE THE STARTING POINT OF EACH BONE ON THE DISPLAY) ARE DETERMINED BY THE VOLTAGE ACROSS THE FEEDBACK CAPACITOR. IF THERE IS NO DISCHARGE OF THAT CAPACITOR, [illegible] INTEGRATION OF A SEQUENCE OF D.C. VOLTAGES WILL BE "JOINED TOGETHER". WHENEVER THE CAPACITOR IS DISCHARGED OR "SHORTED OUT", THE INITIAL CONDITION VOLTAGES ARE [illegible] AND THE DISPLAY BEAM RETURNS TO A "ZERO" OR "STARTING" POSITION. (THE FLYBACK CIRCUIT TO BE DESCRIBED PERFORMS THE FUNCTION OF SHORTING OUT & DISCHARGING THE CAPACITOR AS DESIRED OR REQUIRED TO DRAW A FIGURE OR IMAGE.)

[illegible] THE VALUE OF VOLTAGE PRESENTED TO THE INPUT [illegible] DETERMINES THE SLOPE [illegible] OF VOLTAGE AT THE OUTPUT. THE COMBINATION OF ANY TWO OF THE INTEGRATORS WHEN PRESENTED TO EACH OF THE X & Y DEFLECTION CIRCUITS OF THE DISPLAY CRT, WILL GIVE THE PROJECTION OF THE FIGURE (OR IMAGE BEING DRAWN) ON THE PLANE DETERMINED BY THE COMBINATION. FOR EXAMPLE, IF THE X AND Y INTEGRATORS OUTPUTS ARE USED, THEN THE DISPLAY WILL BE A VIEW WHICH IS THE PROJECTION OF THE FIGURE ON THE X, Y PLANE. SIMILARLY, IF THE Y AND Z OUTPUTS ARE USE, THE VIEW WILL BE A PROJECTION OF THE FIGURE ON THE Y, Z PLANE.

INTERMEDIATE VIEWS MAY BE OBTAINED BY COMBINING ALL THREE INTEGRATOR OUTPUTS IN PROPER AMOUNTS; THUS ALLOWING AN OPERATOR OF THE DEVICE TO VIEW THE OBJECT OR FIGURE FROM ANY POSITION, THE FUNCTION OF COMBINING THESE INTEGRATOR OUTPUTS IN A PROPER FASHION IS CARRIED OUT BY THE "CAMERA ANGLE NETWORK" TO BE DISCUSSED LATER.

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THE VALUE OF VOLTAGE PRESENTED TO THE INPUT OF AN INTEGRATOR DETERMINES THE RATE OF CHANGE OF VOLTAGE AT THE OUTPUT. (SLOPE). IF THE D.C. INPUT VOLTAGES TO THE X AND Y INTEGRATORS REPRESENT THE COS θ AND SIN θ RESPECTIVELY THEN THE OUTPUT OF THE INTEGRATORS WHEN FED INTO THE HORIZONTAL AND VERTICAL AMPLIFIERS ON A DISPLAY SCOPE WILL CAUSE THE BEAM TO DRAW A LINE ON THE SCOPE WHOSE ANGLE TO THE HORIZONTAL IS θ.

SINE [illegible]

BACK NETWORK.

THE FUNCTION OF THE FLYBACK NETWORK IS TO SHORT OUT OR DISCHARGE THE CAPACITORS (C) ASSOCIATED WITH THE INTEGRATORS AT DESIRED TIMES DURING THE SEQUENCE OF BONES AND AT THE END OF ONE CYCLE OF BONE GENERATION. DISCHARGING OF THE CAPACITORS CAUSES THE BEAM OF THE DISPLAY CRT TO FLY BACK TO THE STARTING POSITION.

AN ELECTRONIC SWITCH DISCHARGES THE CAPACITOR. PULSES WHICH CLOSE THE SWITCH COME FROM AN AMPLIFIER WHICH IS IN TURN FED BY PULSES (WHICH ARE SELECTED AS DERIRED) COMING FROM SELECTED MULTIVIBRATORS OF THE MSMV CHAIN. ALSO, A PULSE WHOSE DURATION IS DETERMINED BY THE TIME OF THE LAST MSMV TO THE BEGINNING OF A NEW CYCLE OF THE FIRST MSMV IS GENERATED BY A BISTABLE MULTIVIBRATOR. THIS FLYBACK BI-STABLE MV RECEIVES A PULSE FROM THE LAST MSMV AS IT CLOSES. THIS PULSE FLIPS THE BSMV AND ITS OUTPUT CAUSES THE SWITCHES TO CLOSE, THIS BSMV STAYS IN THE "CLOSED" STATE UNTIL IT RECEIVES ANOTHER INPUT PULSE WHICH THIS TIME COMES FROM THE [redacted] COUNTER, THE SAME PULSE WHICH STARTS THE CHAIN OF MSMV'S.

DIODES CONNECT ALL OF THE PULSE INPUTS TO THE AMPLIFIER WHICH ACTIVATES THE SWITCHES SO AS TO PREVENT PULSES FROM FEEDING BACK INTO THE GATES AND THUS CAUSING THEM TO OPERATE OUT OF SEQUENCE.

THE ELECTRONIC SWITCHES REMAIN CLOSED DURING THE DURATION OF A PULSE, BE IT LONG OR SHORT.

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SKIN NETWORK.

THE FUNCTION OF THE SKIN NETWORK IS TO ALGEBRAICALLY COMBINE THE VARIOUS VOLTAGE REPRESENTATIONS OF $\sin\theta$, $\cos\theta$, $\sin\phi$, $\cos\phi$, K_1t_x, K_1t_y, K_1t_z, $\sin K_2t$ $\cos K_2t$ AND THE VIDEO SIGNAL "A" TO GIVE THE PROPER FORMULAMATIC REPRESENTATIONS OF THE GEOMETRIC PROJECTIONS OF THE FIGURE OR OBJECT BEING GENERATED. FOR QUICK REFERENCE, A TABULAR EXPLANATION OF THESE VARIOUS SIGNALS IS GIVEN BELOW.

$\sin\theta$:
$\cos\theta$: } D.C. VALUES OF VOLTAGE WHOSE RELATIONSHIP IS AS THE SINE AND COSINE OF THE ANGLE θ

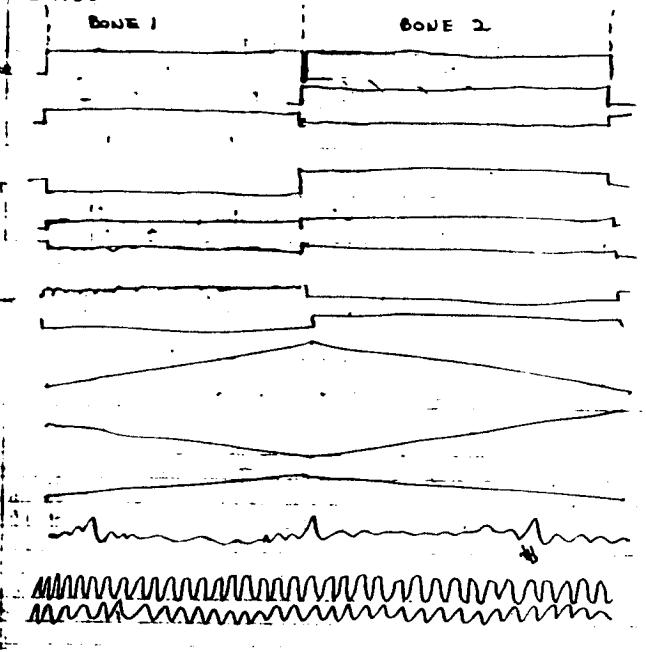
$\sin\phi$:
$\cos\phi$: } D.C. VALUES OF VOLTAGE WHOSE RELATIONSHIP IS AS THE SINE AND COSINE OF THE ANGLE ϕ.

K_1t_x
K_1t_y
K_1t_z } RAMP FUNCTIONS OF VOLTAGE, THE OUTPUTS OF INTEGRATORS X, Y AND Z RESPECTIVELY, WHERE THE CONSTANT K_1 IS A SCALING FACTOR, WHICH IS A DEVICE FUNCTION OF THE GAINS OF DISPLAY AMPLIFIERS, OF THE GAINS OF THE INTEGRATING AMPLIFIERS AND ALSO A FUNCTION OF THE AMPLITUDE OF THE INPUT SINE AND COSINE WAVES TO THE INTEGRATORS. FOR SIMPLICITY THESE EFFECTS ARE ACCOUNTED FOR BY THE USE OF THIS "LUMPED CONSTANT" K_1.

$\sin K_2t$:
$\cos K_2t$: } SINE AND COSINE WAVE FUNCTIONS WHOSE FREQUENCY (THE HIGH FREQENCY) IS DETERMINED BY K_2, AND WHOSE AMPLITUDE IS CONSIDERED TO BE EQUAL TO 1 (ONE UNIT). (FOR A NORMAL MATHEMATICAL REPRESENTATION WE'D HAVE TO USE "a $\sin K_2t$" TO DENOTE THIS WAVE, BUT WE SIMPLIFY THE EXPRESSION BY LETTING $a = 1$ unit, which may = about 10 volts P-P

CAPITAL A IS USED TO DENOTE THE VIDEO SIGNAL WHICH COMES FROM THE SKIN SCANNER. THIS IS A WIDE BAND SIGNAL WHOSE UPPER FREQUENCIES ARE VERY HIGH.

TO SHOW THE INTER-RELATIONSHIP OF THE VARIOUS SIGNALS, A PICTOGRAPH IS GIVEN BELOW FOR 2 BONES



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TWO ALGEBRAIC FUNCTIONS ARE PERFORMED BY THE PORTION OF THE DEVICE WHICH WE CALL THE SKIN NETWORK, NAMELY MULTIPLICATION AND ADDITION.

ASSOCIATED WITH EACH MULTIPLIER ARE INPUT AND OUTPUT AMPLIFIERS, WHICH ARE ELECTRONICALLY NECESSARY TO ALLOW AN ANOLOGUE MULTIPLIER TO PERFORM THE TASK OF MULTIPLICATION. MULTIPLIERS REQUIRE A "CENTER TAP" INPUT, THUS THE THREE INPUTS TO MULTIPLIERS. THE IMPORTANT THING HERE IS NOT HOW WE PERFORM THE PARTICULAR TASK, BUT THAT WE DO PERFORM IT.

ADDERS ARE MERELY RESISTOR NETWORKS WHICH ADD THE VARIOUS SIGNALS PRESENTED TO IT.

ALGEBRAICALLY SPEAKING, THE SKIN NETWORK TAKES THE PREVIOUSLY MENTIONED SIGNALS AND COMBINES THEM SO THAT

$$x = k_1 t_x \cos\theta \cos\phi + A \cos\theta \sin\phi \cos k_2 t - A \sin\theta \sin k_2 t$$

$$y = k_1 t_y \sin\theta \cos\phi + A \sin\theta \sin\phi \cos k_2 t + A \cos\theta \sin k_2 t$$

$$z = k_1 t_z \sin\phi + A \cos\phi \cos k_2 t$$

HERE, X, Y AND Z REPRESENT THE X, Y AND Z VECTORIAL COMPONENTS OF THE FIGURE. BY PRESENTING ANY 2 OF THESE SIGNALS TO THE X AND Y CHANNELS OF A DISPLAY CRT, THE RESULTING DRAWING WILL BE A PROJECTION OF THE 3 DIMENSIONAL FIGURE ON THE PLANE DETERMINED BY THE COMPONENTS SELECTED.

BY THE GEOMETRIC SELECTION AND COMBINATION OF ALL THREE OF THESE COMPONENTS, ANY VIEW OR PROJECTION OF THE 3 DIMENSIONAL FIGURE MAY BE

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CAMERA—ANGLE NETWORK

THE FUNCTION OF THE CAMERA ANGLE NETWORK IS TO ALGEBRAICALLY (AND THUS GEOMETRICALLY) COMBINE THE X, Y, AND Z COMPONENTS OF THE THREE DIMENSIONAL FIGURE IN SUCH A MANNER AS TO ALLOW FOR THE PRESENTATION OF ANY PROJECTION OR VIEW OF THE FIGURE WHEN THE OUTPUTS OF THIS NETWORK ARE PRESENTED TO THE X AND Y CHANNELS OF A DISPLAY CRT.

2 ALGEBRAIC FUNCTIONS ARE PERFORMED. THE FIRST IS MULTIPLICATION BY A CONSTANT, THE SECOND IS ADDITION.

THE "MULTIPLICATION BY A CONSTANT" IS, IN EFFECT THE TAKING OF THE SINE AND COSINE OF THE VECTOR AND IS ACCOMPLISHED BY A NETWORK OF VARIABLE "SINE-COSINE" POTENTIOMETERS. ADDITION IS PERFORMED USING A FIXED RESISTANCE NETWORK.

ANGLES Θ' (THETA PRIME) AND ϕ' (PHI PRIME) REPRESENT THE ROTATION OF THE XY PLANE ABOUT THE X AXIS AND THE XZ PLANE ABOUT THE Z AXIS.

2 SIN-COSINE POTS GANGED TOGETHER (WITH WIPERS ARM ON A COMMON SHAFT) IS THE MECHANISM FOR PERFORMING THE PROPERLY-RELATED MULTIPLICATION BY CONSTANTS, IE TAKING THE SINES & COSINES IN THE PROPER RELATIONSHIP.

THERE ARE TWO SUCH MECHANISMS. ROTATION OF THE SHAFT OF ONE, CONTROLS THE VIEWING ANGLE Θ'. THE OTHER CONTROLS ϕ'. AMPLIFIERS ASSOCIATED WITH THE NETWORK OF SINE-COSINE POTS ARE AN ELECTRONIC NECESSITY.

THE TWO OUTPUTS OF THIS NETWORK ARE FED INTO THE X & Y CHANNELS OF THE DISPLAY CRT, AND REPRESENT THE BEAM-POSITIONAL INFORMATION NECESSARY TO DRAW THE FIGURE

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EVENTUALLY, WE'LL USE CONTROLING SERVO-MOTORS TO POSITION THE SHAFTS OF Θ' + ϕ', SO THAT THE CAMERA ANGLES MAY BE RECORDED ON THE CONTROL-TAPE RECORDER ALONG WITH OTHER CONTROLLING INFORMATION. IN OTHER WORDS, WE'LL RECORD SIGNALS TO WHICH THE SERVOS WILL REACT, THUS RECORDING THE CAMERA ANGLES.

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SKIN GENERATOR.

THE FUNCTION OF THE SKIN GENERATOR IS TO GENERATE A VIDEO SIGNAL; THE MAGNITUDE OF WHICH REPRESENTS THE DISTANCE [redacted] (OR THICKNESS) BETWEEN THE BONE (VECTOR) AND THE SURFACE (OR SKIN) OF THE OBJECT OR FIGURE BEING DRAWN.

THE SKIN GENERATOR IS A FLYING SPOT SCANNER WHICH SCANS A SPECIALLY PREPARE PHOTOGRAPH THE DENSITY OF WHICH CONTAINS THE DESIRED THICKNESS INFORMATION.

GENERAL

THE SKIN GENERATOR IS A HIGH SPEED COMMUTATOR WHICH CONVEYS IN PROPER SEQUENCE AND SYNCHRONIZATION THE THICKNESS INFORMATION WHICH IS RETAINED IN A [redacted] FORM OF INFORMATION STORAGE DEVICE OR MEDIUM.

THE FLYING SPOT SCANNER IS A SPECIAL (SHORT PERSISTANCE) CATHODE RAY TUBE IN WHICH THE BEAM SWEEPS OUT A PRESCRIBED RASTER (PATERN OF LINES). THE BEAM PRODUCES A SHORT PERSISTANCE SPOT OF LIGHT ON THE FACE OF THE TUBE. THIS SPOT OF LIGHT IS OPTICALLY CONDUCTED AND FOCUSED ON THE PHOTOGRAPHIC TRANSPARENCY WHICH TRANSMITS VARYING AMOUNTS OF LIGHT ACCORDING TO THE FILM DENSITY, THUS THE PHOTOGRAPHIC TRANSPARENCY MODULATES THE INTENSITY OF THE LIGHT, AS THE SPOT SWEEPS OR SCANS ACROSS IT. THIS MODULATED LIGHT IS COLLECTED BY A CONDENSING LENS AND EQUALLY FOCUSSED ON A PHOTO-MULTIPLIER TUBE WHICH CONVERTS THE MODULATED LIGHT INTO A VOLTAGE SIGNAL (VIDEO). (IN GENERAL THIS SYSTEM ACTS AS A HIGH SPEED COMMUTATOR, COMMUNICATING MANY PIECES OF INFORMATION IN THE DESIRED STREAM

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OR SEQUENCE.)
THE VIDEO SIGNAL IS THEN ADDED (VECTORIALLY SPEAKING) TO THE BONE SIGNAL AND GIVING THE POSITIONAL INFORMATION TO THE DISPLAY BEAM WHICH REPRESENTS THE THICKNESS OF THE OBJECT OR FIGURE BEING DRAWN.

THE MOVEMENT OF THE FLYING SPOT IS CONTROLED BY DEFLECTION AMPLIFIERS IN SCANNER. THE CONTROLING HORIZONTAL AND VERTICAL DEFLECTION WAVE FORMS ARE GENERATED IN THE DEFLECTION GENERATORS (SAWTOOTH GENERATORS) WHICH ARE SYNCHRONIZED AND DRIVEN BY AN INPUT FROM THE CLOCK.

THE RASTER (PATERN OF MOVEMENT OF THE SPOT) OF THE SCANNER IS BASICALLY RECTANGULAR, WITH SOME LOCALIZED MODIFICATIONS IN THE PATTERN FOR SPECIAL, SKIN-DISTORTION EFFECTS AS IN LIP, EYE & OTHER FACIAL [redacted] AND PLASTIC-TYPE MOVEMENTS. (SUCH AS WRINKLE EFFECTS WHICH WOULD BE AUTOMATICALLY DEVELOPED AS A FUNCTION OF BONE ANGLES.)

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THE SKIN GENERATOR MAY ALSO BE USED TO DEVELOPE OTHER SKIN INFORMATION SUCH AS COLOR, TEXTURE & SHADING. (THIS WILL BE DISCUSSED LATER.)

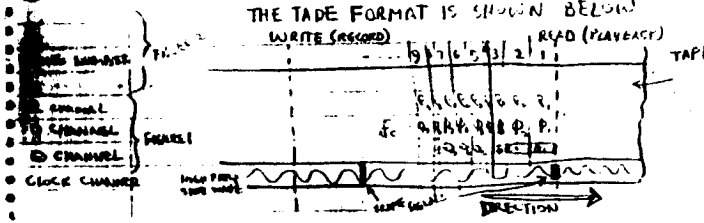
2/

Recording Network: (Tape Recorder)

The Function of the RECORDING NETWORK IS TO RECORD THE joined-rotation SIGNALS (MULTIPLEXED ANGLE-SIGNALS) AND ALLOW FOR THE PLAY-BACK OF THESE SIGNALS. THE RECORDER IS A MULTI-CHANNELED RECORDER. ON ONE CHANNEL IS RECORDED THE CLOCK & FRAME-SIGNALS FOR SYNCHRONIZATION. Sound is recorded on another SELECTIVE RECORDING OF INDIVIDUAL GATE-OUTPUTS OR GROUPS OF GATE-OUTPUTS IS ACCOMPLISHED WITH RECORDING GATES WHICH ARE ACTIVATED (OPENED) BY THE MULTIVIBRATORS ASSOCIATED WITH THE BONE GATES DESIRED TO BE RECORDED. A SWITCH MAY BE EMPLOYED TO HOLD THESE RECORDING GATES OPENED IF IT IS DESIRED TO RECORD ALL OF THE BONES. (AS AN OPERATOR MAY DO AT THE BEGINNING OF AN ACTION)

~~THE TAPE MOVES ACROSS THE WRITE HEADS ARE OF THE TAPE RECORDED FIRST, THEN ON TO THE~~ (READ HEADS) SITUATED "UPSTREAM" FROM THE READ HEADS AS FAR AS TAPE MOTION IS CONCERNED. THE SIGNALS WHICH ARE PASSED BY THE RECORDING GATES ARE THENCE RECORDED ON THE TAPE BY THE WRITE HEADS. THE SIGNALS THUS RECORDED ARE ALMOST IMMEDIATELY READ BY THE "READ" HEADS FROM WHICH THE SIGNALS ARE AMPLIFIED AND SENT INTO THE BONE GENERATION NETWORK.

THE TAPE FORMAT IS SHOWN BELOW



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THE CLOCK CHANNEL HAS RECORDED ON IT THE HIGH FREQUENCY SINE WAVE PLUS THE INTERMITTANT FRAME PULSE. THESE SIGNALS ARE SEPARATED (ELECTRICALLY) AFTER READING, AND THE SIGN WAVES ARE SENT TO THE BONE GENERATOR & THE FRAME PULSES ARE SENT TO THE COUNTER CHAIN.

AFTER THE θ AND φ (TAPE) CHANNELS ARE FILLED WITH RECORDED SIGNALS, SELECTIVE RE-RECORDING IS ACCOMPLISHED BY MAKING CONNECTIONS BETWEEN SELECTED MSMV's & THE RECORDING GATES, SO THAT THE GATES ARE OPENED ONLY DURING THE TIMES OF OCCURRENCE OF THE OPENING OF THE θ & φ GATES ASSOCIATED WITH THE SELECTED MSMV's, (THE INITIAL RECORDING SWITCH IS OPENED)

FOR EXAMPLE, SUPPOSE AN OPERATOR WISHED TO RE-RECORD THE ANGULAR ACTIONS OF THE 4th & 5th BONES. HE'D CONNECT THE PULSED OUTPUT OF MSMV's # 4 & 5 TO THE RECORDING GATE ACTUATT ACTUATING INPUT TERMINAL OF THE RECORDING GATE. THUS THE ONLY TIME RECORDING WOULD TAKE PLACE WOULD BE AT THE EXACT SPOTS ON THE TAPE THAT CORRESPONDED TO THE PREVIOUSLY RECORDED ACTIONS OF BONES 4 & 5. THE WRITE HEAD IN BEING ACTIVATED AT THOSE TIMES WOULD OBLITERATE THE PREVIOUSLY RECORDED SIGNALS AND LEAVE THE NEWLY DESIRED SIGNALS ON THE TAPE. THE REST OF THE TIME, THE RECORDING GATES ARE CLOSED. THE READ HEADS PICK UP THE OLD AS WELL AS THE NEW SIGNALS, AND TRANSMITT THEM THROUGH THE DEVICE TO STIMULATE THE DESIRED ACTION ON THE DISPLAY.

OTHER TAPE CHANNELS ARE USED IN SIMILAR FASHION TO RECORD AND CONTROL OTHER PARAMETERS OF THE BONE. FOR EXAMPLE, THE ρ (RHO) CHANNEL IS USED TO CONTROL THE ROTATIONAL POSITION (OR TWIST) OF THE SKIN ALONG THE BONE AXIS.

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CONTROL OF MOTION & OTHER PARAMETERS

BY CONTROLING THE VOLTAGE INPUTS TO THE BONE GATES, THE POSITIONS, ATTITUDES, AND OTHER SPACIAL PARAMETERS ARE CONTROLED. THE FUNCTION OF THE CONTROLS IS TO GENERATED THE DESIRED SIGNALS FOR THE VARIOUS MOTIONS. IN GENERAL, THE CONTROLLING SIGNALS ARE VERY LOW FREQUENCY AND IN SOME CASES PRACTICALLY D.C. (THE SAMPLING RATE FOR EACH BONE SIGNAL TO BE MULTIPLEXED IS 24 TIMES PER SECOND. IN ONE SECOND, UNLESS THE ACTION OF A BONE IS VERY SWIFT, THE VOLTAGE VARIATION FROM THE BEGINING TO THE END OF ONE DRAWING CYCLE ($\frac{1}{24}$ sec) OF ONE BONE ($\approx \frac{1}{2}$, ($\frac{1}{20}$)(1) = $\frac{1}{40}$ DAC) IS VERY SLIGHT. THAT IS TO SAY, SUPPOSE THE VOLTAGE VARIES 5 VOLTS IN ONE SECOND DUE TO THE TURNING OF A POTENTIOMETER, THEN THE VARIATION FROM THE BEGINNING TO THE END OF A BONE IS $\frac{1}{40}$ VOLTS WHICH IS SUCH A SMALL CHANGE THAT THE BONE APPEARS STRAIGHT.)

NETWORKS OF VARIABLE RESISTORS AND VERY LOW-FREQUENCY GENERATORS MAY BE USED TO GENERATE INTERRELATED BONE-GROUP ACTIONS OR MOTIONS. AS THE MANIPULATION OF THE POTENTIOMETER INPUTS IS SIMPLIFIED, IT MAY BE CONSIDERED THAT THE 'CONTROLS' MAY BECOME MORE AND MORE COMPUTER-LIKE, WHERE MANY MOTION FUNCTIONS ARE GENERATED AUTOMATICALLY.

SHAPED WAVEFORMS IN PLACE OF D.C. INPUTS WILL GIVE BONES OTHER THAN STRAIGHT. FOR EXAMPLE, A SAWTOOTH CONTROL INPUT WILL GIVE A WIGGLY

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BONE; A SINUSOIDAL INPUT (IF AT THE PROPER PHASE & FREQUENCY) WILL MAKE A CIRCULAR BONE; A SQUARE (TYPE) WAVE INPUT WILL MAKE A ZIG ZAG OR SAWTOOTH TYPE BONE; A RAMP INPUT TO THE BONE GATES WILL MAKE A CURVED OR ARCHED BONE.

SPECIAL COMPOSITE WAVEFORMS MAY ALSO BE INSERTED either BEFORE OR AFTER THE INTEGRATOR, WITHOUT PASSING THROUGH THE SAMPLING NETWORKS. IN ORDER TO PRODUCE DESIRED MUTATIONS ON THE BONES (TECHNIQUES SUCH AS THESE HAVE BEEN DISCUSSED ON MANY OCCASIONS AND WILL BE EXECUTED WHEN TIME ALLOWS)

JOY-STICKS & FINGER CONTROLS HAVE BEEN DESIGNED FOR EASY, MECHANICAL MANIPULATION OF THE CONTROLS & MAY BE THE SUBJECTS OF LATER PATENTS. SPECIAL CONTROLLING INPUTS FOR FACIAL EXPRESSIONS MAY BE TRANSDUCED FROM ACTUAL FACIAL & LIP MOTIONS USING A NETWORK OF STRAIN GAGES

SHADING (AND COLOR) NETWORK

Lee Harrison III

12/29/61

THE ELECTRONIC SIGNALS COMING OUT OF THE CAMERA ANGLE NETWORK ARE BEAM-POSITIONING SIGNALS; (JUST AS FINGERS CONTROL THE POSITION OF A PENCIL ON PAPER). THE FUNCTION OF THE SHADING (AND COLOR) NETWORK IS TO GOVERN THE BEAM INTENSITY AS IT DRAWS THE FIGURE OR OBJECT. ~~AND IS CONFINED TO THE USED SPEED~~ (HIGH FREQUENCY) VARIATIONS IN INTENSITY ASSOCIATED WITH SKIN SHADES & SHADOWS, TEXTURE ~~WRINKLES~~ ETC, WHICH ARISE FROM THE SURFACE VARIATIONS IN THE SKIN. (COLOR VARIATIONS IN THIS SENSE ARE THOUGHT OF IN TERMS OF A THREE-COLOR (MULTI-COLOR) PROCESS WHERE FOR EXAMPLE THE IMAGES OF THREE DISPLAY SCOPES, ARE OPTICALLY SUPERIMPOSED, AND EACH SCOPE HAS A COLOR FILTER ON ITS FACE. BY VARYING THE INTENSITIES OF THE 3 BEAMS, THE OPTICAL IMAGE HAS FULL SPECTRUM COLOR CAPABILITY. THUS THIS TOPIC IS CALLED "SHADING (AND) COLOR NETWORK.)

THE SKIN VIDEO SIGNAL CONTAINS THE INFORMATION ABOUT THE ORTHOGONAL DISTANCE BETWEEN BONE AND SKIN. IN THE FULL BASIC FORMAT, THE RATE OF CHANGE OF THE VIDEO SIGNAL IS USED TO CONTROL THE BRIGHTNESS (SHADING) OF HIGH FREQUENCY SKIN VARIATIONS TO ACCENTUATE SKIN FEATURES WHICH OCCUR BETWEEN THE EDGES OF THE OBJECT BEING DRAWN IN THIS FORMAT. BY DIFFERENTIATING THE SKIN VIDEO A RATE-OF-CHANGE SIGNAL IS OBTAINED. A THRESHOLD NETWORK DETECTS ALL RATES INCREASES ABOVE A PRESCRIBED ABSOLUTE VALUE, THE CLIPPED OUTPUT OF THE THRESHOLD NETWORK IS AMPLIFIED AND ~~SCALED~~ THENCE USED TO MODULATE BEAM INTENSITY.

~~SHADING~~, EDGE EFFECTS (EDGE SHADOWS ETC)

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ARE PRODUCED IN ACCORDANCE WITH THE SKIN VECTOR POSITION WHICH IS A FUNCTION OF THE PHASE OF THE HIGH FREQUENCY SINE WAVE FROM THE CLOCK. IN ADDITION, A HIGH FREQUENCY WOBBLE OR A FOCUS FLATTER MAY BE EMPLOYED TO HEAVY-UP OR THICKEN THE EDGES, THIS ACTION ALSO BEING ~~IN CONJUNCTION~~ SYCHRONOUS WITH PHASE OF THE SINE WAVE.

DO NOT VARY WITH BONE POSITION, FLAT COLOR EFFECTS, OR GRAYS OR TEXTURES WHICH MAY BE PRODUCED BY GATING IN THESE INTENSITY MODULATING SIGNALS ~~IN CONJUNCTION WITH~~ BEING THE BONE GATES DESIGNED FOR THAT PURPOSE. THE INPUT TO THE GATES IS A HIGH FREQUENCY OF A CERTAIN PATTERN, WHICH WHEN APPLIED TO MODULATE THE BEAM INTENSITY DURING THE DRAWING OF A PARTICULAR BONE WILL GIVE A TEXTURED PATTERN. MORE SPECIFICALLY, VIDEO SIGNALS ~~CONTAINING DESIGNS~~ OF PRESCRIBED DESIGNS MAY BE APPLIED IN THIS MANNER TO GIVE THE DESIRED EXTERIOR APPEARANCE OF AN OBJECT ~~BONE SKIN~~ AS A SOAP BOX OR OTHER CONSUMER PRODUCT, OR A SHIRT PATTERN (ON A MAN FIGURE) OR A FUR PATTERN (ON AN ANIMAL CHARACTER) (TO GENERATE THIS INTENSITY VIDEO, ANOTHER SCANNER WOULD BE REQUIRED, OR A SPLIT-IMAGE SCANNING TECHNIQUE WHERE OPTICAL MEANS, (MIRRORS) ARE USED TO HAVE THE SKIN-SCANNING RASTER OF THE FLYING SPOT FOCUSED ON TWO (OR MORE) FILMS - WHERE ONE FILM CONTAINS THICKNESS INFORMATION AND ANOTHER CONTAINS SURFACE COLOR, PATTERN OR TEXTURE INFORMATION.

OVERLAP PREVENTION AND SCAN CONVERSION

BECAUSE THE DISPLAY BEAM IS DRAWING A 2-DIMENSIONAL PROJECTION OF A 3-DIMENSIONAL IMAGE IN A CONTINUOUS MANNER IT IS NECESSARY TO PROVIDE A MEANS OF PREVENTING THE BEAM FROM DRAWING OVER A PORTION OF THE IMAGE WHICH HAS ALREADY BEEN DRAWN. THUS A SPECIAL DEVICE FOR "OVERLAP PREVENTION" HAS THE FUNCTION OF DOING AWAY WITH "GHOST" IMAGE OR OVERLAP.

OVERLAP MAY BE CLASSIFIED INTO TWO TYPES. ONE TYPE OCCURS WHEN THE "BACK PART" OR PART OF THE IMAGE ON THE SIDE AWAY FROM THE VIEWER IS DRAWN. THIS OVERLAP IS PREVENTED BY TURNING OFF THE INTENSITY OF THE BEAM ACCORDING TO THE VECTORIAL POSITION OF THE SKIN VECTOR WHICH IS A FUNCTION OF 1) PHASE OF THE HIGH FREQUENCY, AND 2) THE CAMBRA ANGLE (WHICH GOVERNS THE POSITION OF THE PLANE OF PROJECTION).

THE 2nd TYPE OF OVERLAP OCCURS WHEN ONE PART OF AN OBJECT OR FIGURE OVERLAPS ANOTHER PART, OR WHERE ONE FIGURE IS IN FRONT OF ANOTHER. BY USING A SPECIAL DISPLAY TUBE WHICH HAS IN IT, TWO OR MORE ELECTRON GUNS, ONE OF WHICH IS A "WRITE" GUN, ANOTHER OF WHICH IS AN "ERASE" GUN (HAVING SELECTIVE ERASURE CAPABILITY). AND HAVING THE ERASE GUN PRECEDE THE WRITE GUN BY EMPLOYING A SLIGHT DELAY IN THE "WRITE" SIGNALS (BOTH GUNS GETTING THE SAME DISPLAY SIGNALS HOWEVER) OVERLAP MAY BE PREVENTED, AS LONG AS THE OBJECT OR PART OF THE OBJECT WHICH IS TO BE DISPLAYED IS DRAWN IN THE SAME SEQUENCE COMPATIBLE WITH THIS METHOD (NAMELY, LAST

A MULTI-GUN SCOPE THUS EMPLOYED WILL CONTAIN THE IMAGE THUS DRAWN FOR A LENGTH OF TIME NECESSARY FOR PHOTOGRAPHING OR SCAN CONVERTING. A SCAN CONVERSION TUBE MAY BE USED TO TRANSFORM THE DRAWN IMAGE INTO A SCANNING PATTERN WHICH IS COMPATIBLE WITH TELEVISION TRANSMISSION OR A CLOSE-LINE RASTER WHICH WOULD BE COMPATIBLE FOR THE SUPERPOSITION OF FIGURES ON A BACKGROUND.

AT THIS POINT IN THE GENERATION OF ANIMATED PICTURES IT IS NECESSARY TO CONSIDER PICTURE QUALITY IN TERMS OF RESOLUTION. THE PROBLEM OF RESOLUTION BECOMES ACUTE WHEN HIGH SCANNING SPEED NECESSITATES HIGH BANDWIDTH REQUIREMENTS. THUS IT IS CONTEMPLATED THAT THE SPECIAL PICTURE TECHNIQUES (SUPERIMPOSITION - OVERLAP PREVENTION - SCAN CONVERSION) WILL BE CARRIED ON AT A RELATIVELY SLOW RATE — ie NOT AT THE SAME SPEED AT WHICH WE ANIMATE. AN OPERATOR MAY DO HIS ANIMATION IN REAL TIME (WHERE THE DEVICE CONTROL PUTS THE SIGNALS INTO A 24/FRAME/SEC FORMAT) BUT THE EVENTUAL FILM-RECORDING OF THE ANIMATED SEQUENCES WILL BE AT A SLOWER RATE, AND OF COURSE ALL AUTOMATION CONTROLED BY THE PRE-PROGRAMMED ANIMATION.

WITH LOW REPRODUCTION SCANNING RATES, HIGH RESOLUTION CATHODE RAY TUBE DISPLAY COMPATIBLE WITH 35mm FILM GRAIN MAY BE ATTAINED.