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(54) **Method and apparatus for generating a set of signals representing a curve.**

(57) Disclosed is a method and system of encoding data representing knots on an outline loop defined relative to a coordinate plane, for producing a display image of said outline and decoding responsive to the interrelationship of said knots on said outline loop, and imaging said outline loop responsive to said decoded data involving selecting sets of coordinates on said outline loop, to represent said knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order. In the method a complete information set is encoded of data indicative of the coordinate distances and interknot angles between adjacent knots. The relative positions of successive knots are compared to at least a first interknot criterion responsive to the comparing. When compared, the method further comprises producing a first indication that a set of said successive knots is within said criterion, or ii) producing a second indication that a set of said successive knots is outside said criterion, and i) responsive to said first indication imaging said outline loop in the form of a smooth continuous curve, or ii) responsive to said second indication, imaging said outline loop in the form of a straight line, between said set of successive knots. Further disclosed is the encoded data representing the knots on an outline defined relative to a coordinate plane and decoded for use in a

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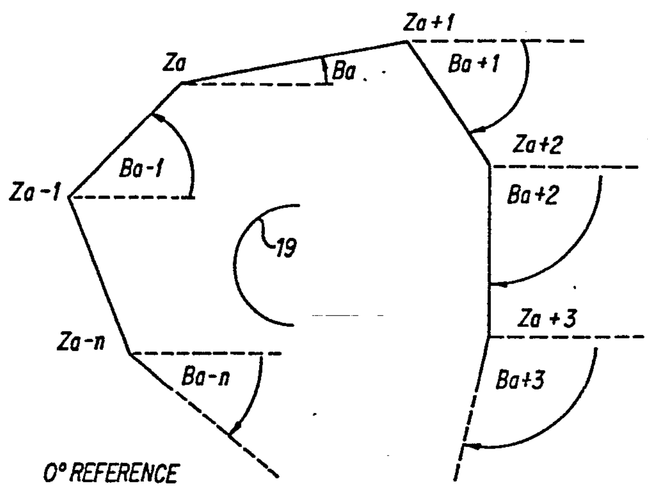

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display process to produce images of said outlines represented by said encoded data involving selecting sets of coordinates on said outline, to represent said knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order, by encoding a complete information set of data providing a control code indicative of either i) the coordinate locations of said knots or ii) a knot's direction relative to others of said knots or iii) a predetermined shape of said outline between a pair of said knots or iv) data indicative of the shape of said outline at a knot, or v) providing data indicative of the coordinate distances between adjacent knots decoding said complete information sets in a decoding order related to said data order, responsive to said complete information set being indicative of the coordinate distances between adjacent knots, producing an image of a smooth continuous curved outline or a straight line between said adjacent knots or responsive to said complete information sets being indicative of a control code as set forth in i), ii), iii), or iv), producing an image of a smooth continuous outline or a straight line according to the said coordinate locations of said knots relative to adjacent knots in said successive knot order or producing an image of said outline being smooth at respective knots or being sharp and forming cusps at respective knots.

FIELD OF THE INVENTION

This invention relates to the field of encoding data related to a variable size character for access and display, and particularly, to the encoding of display points projected in the shape of a continuous smooth curve. The field of this invention is the field of character and symbol generation with continuous and smooth outline curves.

DESCRIPTION OF THE PRIOR ART

The prior art contains many examples of character generating methods and systems. One such example is U.S. Patent 4,029,947 ('947) which generates characters from a single encoded master but uses straight line interpolation to approximate curves between a set of given points. Other encoding systems are shown in U.S. Patent No. 4,298,945 ('945) and U.S. Patent No. 4,199,815 ('815), which also show a system of encoding straight lines using the end points and then interpolating points on the locus of straight lines between the end points and about the outline of a character. A further patent is U.S. Patent No. 4,338,673 ('673), which stores a character in a single size by encoding straight line outlines of the character and then uses that encoding to generate points along straight line approximations of the outline at a desired size, as in the '945 patent and the '815 patent.

However, these and other curve generation techniques do not use a system whereby the coordinate points on the outline of a character are encoded in a single master and then, by utilizing a parametric cubic expression of a single variable, a series of signals describing nodes on the locus of a smooth continuous curve between those points, are generated for display of the character at any variable size.

Parametric cubic curves are known and shown in "Fundamentals of Interactive Computer Graphics", J.D. Foley and Andries Van Dam; Addison Wesley, Reading Mass, 1982. Shown therein are parametric cubic curves, as functions of a single variable, used to represent curve surfaces.

Further, T_EX and METAFONT, Donald E. Knuth; American Math Society, Digital Press, Bedford, Massachusetts, 1979, shows the use of a parametric cubic curve wherein, given the coordinate positions of a set of end points and the first derivative (slope) of a curve at the end points, a parametric cubic polynomial (a function of a single parameter t), can be used to generate the locus of points on a smooth continuous curve segment between those end points. As shown by Knuth, the locus of each curve segment depends on the location of the two end points of that segment, for example, Z_1 and Z_2, and the angle of the curve at Z_1, determined by the location of adjacent points $Z_\emptyset$, Z_2 and Z_3. In fitting the curve between two end points, the angles at Z_1 and Z_2 are predetermined by Knuth. For example, where the curve is from $Z_\emptyset$ to Z_1 to Z_2, Knuth assumes, as a rule, the direction the curve takes through Z_1 is the same as the direction of the arc of a circle from $Z_\emptyset$ to Z_1 to Z_2. However, not all curved outlines will satisfy this rule and, in many cases, Knuth requires a further adaptation of that foregoing process to produce the desired shape, namely of a curve representing the actual smooth curved outline of a character.

Knuth's process starts using the rule described above specifying a circle when fitting a curve between three given points Z_1, Z_2, Z_3. Knuth does show that a parametric cubic curve as a function of a single parameter t, as also shown in "Fundamentals of Interactive Computer Graphics", can be modified, as shown on page 20 of Knuth, to include "velocities" specified as "r" and "s" and which are functions of the entrance angle and exit angle of the curve segment at the given end points. The velocities' values determine how the resulting curve will vary as a function of t, either slowly describing a longer curve distance or more quickly describing a shorter curve distance. The r and s formulas are arbitrary and, in the case shown by Knuth, are chosen to provide excellent approximations to circles and ellipses when θ equals ϕ and $\theta + \phi$ equals 90 degrees. Additional properties chosen to be satisfied by Knuth's arbitrary formulas for r and s are further described in T_EX and METAFONT.

In addition to Knuth's internal requirement to specify an entrance and exit angle at the curve end points, where no previous angle or curve history is given, Knuth also must use the circle approximation rule, specified above, for each of the end points on the curve. This means that where the actual curve to be generated is not accurately produced by the Knuth circle approximation, an adjustment must be made. Knuth makes this adjustment by manipulating adjoining points. For example, where the curve is to be fit between points Z_1, Z_2 and Z_3. Knuth may manipulate the locations of Z_0 or Z_1 or Z_3 or Z4 to obtain an accurate fit. A further problem in Knuth occurs when the sign of θ is the same as the sign of ϕ implying a) the curve entrance angle at point Z_1 is in the same quadrant as the curve exit angle at Z_2, b) a sine wave between Z_1 and Z_2 and c) an inflection point. Knuth must resort to a manipulation of point locations to obtain a desired smooth curve around the inflection point.

In summary, the processes described above for producing outlines and showing the use of a parametric cubic curve expressed as a polynomial capable of generating a series of points along the locus of a curve between two given points can only do so with the disadvantages noted above. In the following summary of the invention, the method and system for using a parametric cubic curve which accurately reproduces a curve section between given points is shown and described and which method and system avoids the disadvantages discussed above.

SUMMARY OF THE INVENTION

This invention has as its object the generation, encoding and display of a series of points (nodes) along the locus of a curve segment between two given end points which are defined as "knots". It has been specifically developed to generate the locus of points (nodes) along the smooth curved outline of characters or symbols between given knots (i.e., Z_{a-1}, Z_a, Z_{a+1} . . . Z_{n-1}, Z_n), but it should be understood that its use is not necessarily limited to that purpose but may be used to generate and display smooth continuous curves between any end points, regardless of the application.

In the case of the applicant's preferred embodiment, the knots are coordinate points along the outline of a character, which may be an alphanumeric or any other character or symbol and which coordinate points may be representative of a master size encoded character at a normalized size, on a dimensionless normalized encoding grid. The coordinate points may be decoded for display at a predetermined normalized display size or at an expanded or reduced size. The knots may be along any outline or surface whether two or three dimensional, although the applicant's preferred embodiment is shown in a two-dimensional model for use in smooth continuous curve generation. Using the method and system of applicant, the nodes along a two-dimensional curve or three-dimensional surface locus may be generated. The system shown herein generates the nodes using the encoded knot positions and the slopes of the curve at the knots. The process generates signals representing the nodes' coordinate values and is based upon the length (Z) between the knots and the angular interrelationship (B) of each of the knots with respect to a reference angle on the encoding grid.

In the preferred embodiment, the knots' coordinates are encoded in a closed data loop and represent dimensionless coordinates about the closed outline loop of the character or symbol. The method described herein enters the closed data loop at a set of encoded coordinates representing a knot on the closed outline loop and initiates the node generating process by using the angular interrelationships of the knots about that entry knot. However, other methods may be used to initiate the process without departing from the inventive concept. In applicant's preferred embodiment, once having entered the encoded closed data loop, the analysis may proceed in a clockwise or counterclockwise direction around the closed data loop.

It should be understood that the principles of this invention are not limited to a closed outline loop or closed data loop, but may be applied to open outline loops and to open data loops.

The process may be used to generate either a smooth continuous curve between the knots or some other form of curve, forming a cusp at a knot for example, and which although continuous, it is not smooth at all locations but angular, as in the shape of a "K" or "G". In the preferred embodiment of the invention, the selection of a smooth continuous curve or merely a continuous curve, having a cusp for example, is made using stored rules which serve as default command codes which use the interknot angles formed between the knots, and the distance between the knots to produce a desired result. For example, where the angle formed by two knots is in excess of a predetermined threshold angle, a default command code may direct that a cusp be formed. Other rules such as override control codes may be similarly used to force a cusp or smooth curve, regardless of the threshold conditions and which may be encoded in the closed data loop to override the default command codes as explained below.

Assuming, for the purpose of explaining the invention, it is desired to connect all knots in the closed outline loop with smooth continuous curves, the angles formed between an entrance knot at which the representative encoded data loop is entered and the first and second successive knots thereto in a chosen progression of knots in the closed outline loop are averaged to produce average angle values. As the curve formed between knots is a continuation of a curve which enters at the first of the knots (Z_a), and which exists at successive or at a second of the knots (Z_{a+1}), the tangent angles of the curve, which are the entrance angle at the first knot and exit angle at the second knot can be specified as average angles. The analysis continues by proceeding around the closed outline loop in the established progression of knots and the order thereof of the knots and examining the angles formed between the knots as described above.

As the knots form a master skeletal outline of the character or symbol when juxtaposed on a dimensionless encoding grid, arranged at a normalized size, the knots may be rotated or scaled relative to such a normalized encoding grid. Once the master encoded character or symbol (master encoded character) is scaled and positioned as desired, then the analysis described above, may continue wherein a) the encoded closed data loop of knots in the closed outline loop is entered at a first set of coordinates representing a first knot, b) the angular and spacial relationships of the knots on the normalized encoding grid are determined, using the representative encoded data and c) for each set of knots along the closed outline loop, assuming that each knot is to be connected by a continuation of a smooth curve, the average angles of the respective curve segments entering and exiting the respective knots are determined. Where a smooth continuous curve is desired, then the entrance angle of the curve segment at a knot would normally be the same as the exit angle of the curve from that same knot.

By using the foregoing method of analysis, namely, determining the average angles made by the curve passing through the knots, and using those average angles to represent the slope of the tangents to the particular curve segment at the respective knots, the disadvantages shown in the prior art are overcome.

In particular, in this inventive concept, there is no need to define a circle between the knots and then compute the locus of nodes on the circle as Knuth does. A faster process results using this invention which requires only the interknot angles of the knots relative to each other and to a reference angle be known. The process as stated above, uses a parametric cubic polynomial relationship of a single variable t to generate signals or data, indicative of and representing the coordinates of nodes on the locus of a smooth continuous curve segment between sets of respective knots. Where a greater resolution and greater number of nodes is needed to describe the locus, then the incremental value of the parameter t, may be decreased providing a greater number of discrete cumulative values of t and node coordinates. Where less resolution and fewer nodes are needed to define the locus, then the incremental value of t can be enlarged, producing fewer discrete cumulative values of t and nodes.

In the preferred embodiment, the dimensionless normalized master encoding grid represents an EM Square (M^2) of 864 by 864 Dimensionless Resolution Units (DRU's) in each of the X, Y axes. The M^2 is a measure used in the typesetting trade wherein a character is set within an M^2 and is shown herein in a manner consistent with the application of the inventive principles in the preferred embodiment. When the master encoded character is to be displayed, the master encoded character, at a normalized size on the normalized encoding grid is scaled, the knot coordinate positions at the scaled size are encoded and expressed in the appropriate display intercept units such as Raster Resolūtion Units (RRU's). These scaled encoded knots in the preferred embodiment are expressed in terms of the display RRU's and used to determine the incremental value of t. The incremental value of t is used to generate discrete cumulative values of t which are then applied to the cubic parametric polynomial to generate the node coordinates. Then through the cubic parametric polynomial relationship, signals indicative of the coordinates of the nodes are generated and stored as data. As defined by a parametric expression of a single parameter t, the resultant node's x, y coordinate values (X or Y are the axial directions in the preferred embodiment), vary separately as separate functions of t [i.e. x(t), y(t)]. At the scaled size, the incremental value of t may be related to the reciprocal of the distance between knots expressed in RRU's (i.e. $Z_d = | Z_n - Z_{n-1} |$) or any other suitable method may be used to produce a value of t. Values representing the node coordinates are then generated using these incremental values of t, each value being added, to the previous cumulative values (with the second incremental value of t being added to the first incremental value of t and the third incremental value of t being added to the previous cumulative value of t and so on). In the preferred embodiment, the value of t is set to vary from 0 to 1.

The resulting series of signals, stored as encoded data, represent knots and nodes which define the locus of the smooth continuous curve between the knots and the outline of the character or symbol is a machine part ultimately used to control or modulate a display to form the desired character or symbol at the desired size, in a visual image. The resultant data may be run length data, which is applied directly to a raster beam, to position the beam and energize the beam accordingly, or may be used to control a free running raster. Interpolation, rounding or truncating of value may be used to locate the nodes on the display intercepts corresponding to the raster line locations, where exact coincidence is lacking.

As previously stated, as characters or symbols are not always smooth curves but may contain cusps, a threshold test may be used, such as one based on the exterior angle formed by lines between knots. Where that exterior angle at a knot is greater than a predetermined threshold angle, for example, a cusp may be assumed. It being understood, however, that if the exterior angle is less than the threshold angle, the analysis previously described with regard for producing a locus of nodes to define a smooth continuous curves would be used.

In the preferred embodiment, the master encoding grid is a Cartesian coordinate system. As the preferred embodiment is used in typesetting, the encoding grid relative to which the character is encoded is set within an

M^2, which in the preferred embodiment contains 864 by 864 Dimensionless Resolution Units (DRU's). The master encoded character, at its normal size is set over a portion of the available normalized encoding grid area of the M^2. As is known in the typesetting field, expansion areas in the M^2 are also provided for large size characters. The character may be scaled, rotated or projected by ordinary known techniques and new coordinates for the knots may be determined accordingly, as is known in the art. In the preferred embodiment, the scaling is done in increments of 1/1024 DRU's. The new coordinate locations of the knots for the character at its scaled, rotated or projected positions are determined. As only integers are used in the preferred embodiment, any fraction or equivalent thereof is discarded. In the process, the percent of reduction or enlargement is first calculated in relation to a desired character size in units of typesetter's points. The precision of the scaling is increased by an autoscaling linear interpolation increaseing the resolution of the linear interpolation, as explained below. The result is a scaled coordinate point in RRU's without the need to utilize floating point arithmetic.

In the preferred embodiment and as stated above, override control codes are accessed responsive to data stored with the stored knot coordinates to reduce storage and the processing time.

The code 0 is used to indicate the end of all the loops.

A code 1 is used to indicate the movement in a relatively long direction on an axis, for example, the X axis. In this case, an X value is replaced with a new X coordinate value.

The code 2 indicates the same process as a code 1 for another axis, for example, the Y axis direction, where the Y value is replaced with a new Y coordinate value.

A code 3, as in codes 1 and 2, indicates X and Y are both replaced with new coordinate values.

A code 4 indicates the finish of a previous encoded loop and the start of a new loop.

Codes 5, 6 and 7 indicate that the X,Y or XY directions are respectively altered.

Codes 8 to 11 are editing commands forcing predetermined conditions for the curve at the respective knots as will be described.

The knots may be encoded in the closed data loop on a 4-bit memory boundry (nibble) and in the preferred embodiment, the first nibble value of a complete information set of nibbles is used to specify the number of nibbles used in the complete information set.

Additionally, the data is packed in a novel manner which can be interpreted as spacial information or control codes, as will be explained.

In summary, the inventive concept is a process and system for transforming a machine part, in the form of signals, encoded as data and representing a pattern of knots on the outline of a master size symbol, into a similar pattern at a reduced or enlarged size or transposed in space, by generating a series of encoded data signals representing nodes which more definitely define the said pattern in the shape of smooth continuous curves or cusps and which data signals may be directly used to control a display process to visually display the pattern.

Accordingly, what is disclosed is a method and system for generating a series of signals representing nodes on a locus of a curve partially defined by a set of related knots, encoded as data, with said knots defining the end points of respective segments of said curve locus and with said knots being in a successive order in relation to said locus, and for encoding said node signals as data for use when representing said curve segments in a separate additional process responsive to the shape of said curve locus, as represented by said encoded node signals. The method and system involve defining the locations and the successive order of said knots on said curve locus and encoding as data, signals indicative of said knots, then for a first knot, (Z_a), representing a first end point of a first curve segment, deriving a first angle, indicative of the average of the interknot angles between said first knot (Z_a), and selected related knots and encoding as data, signals indicative of said first angle, at a second of said knots (Z_b), representing a second end point of said first curve segment, establishing a second angle for said first curve segment, and encoding as data, signals indicative of said second angle, establishing a compiler for compiling data according to a cubic parametric polynomial relationship between a parameter "t", said knots and angles at the said end points of a said curve segment and the locus of a said curve segment, establishing a range "R" of values for said parameter "t", applying said signals indicative of the said locations of said first and second knots of said first curve segment, to said compiler, applying said signals indicative of the said first and second angles of said first curve segment to said compiler, applying a signal indicative of a distinct selected value of said parameter "t" within said range "R", to said compiler to derive a signal indicative of a respective node location on said first curve segment, repeating the above by applying signals indicative of additional distinct selected values of said parameter "t", within said range "R", to derive a plurality of signals indicative of respective node locations on said locus of said first curve segment for respective distinct selected values of said parameter "t", and encoding said signals derived in step h) and i), in a data base to represent said first curve segment.

Further disclosed is a method of encoding data and an encoded data system representing knots on an outline defined relative to a coordinate plane involving selecting sets of coordinates on said outline, to represent the knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order, and encoding by encoding a complete information set of data providing a control code indicative of either i) the coordinate locations of said knots or ii) a knot's direction relative to others of said knots or iii) a predetermined shape of said outline between a pair of said knots or iv) data indicative of the shape of said outline at a knot or v) encoding a complete information set providing the coordinate distances between adjacent knots.

Further disclosed is a method and system for encoding data representing knots on an outline defined relative to a coordinate plane and for generating a series of signals representing nodes on the locus of a curve partially defined by said set of knots, involving selecting sets of coordinates on said outline, to represent said knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order, and encoding a complete information set of data providing a code indicative of a predetermined shape of said outline between a pair of said knots or a complete information set providing the coordinate distances between adjacent knots.

Further disclosed is a method and system for generating a series of signals representing nodes on a locus of a curve partially defined by a set of related knots, encoded as data, with said knots defining the end points of respective segments of said curve locus and with said knots being in a successive order in relation to said locus, and for encoding and decoding said node signals as data and for use of said data when in an imaging process responsive to the shape for said curve segments as represented by said encoded data, involving defining the locations and the successive order of said knots on said curve locus and encoding as data, signals indicative of said knots, for a first knot, (Z_a), representing a first end point of a first curve segment, deriving a first angle, indicative of the average of the interknot angles between said first knot (Z_a), and selected related knots and encoding as data, signals indicative of said first angle, at a second of said knots (Z_b), representing a second end point of said first curve segment, establishing a second angle for said first curve segment, and encoding as data, signals indicative of said second angle, establishing a compiler for compiling data according to a cubic parametric polynomial relationship between a parameter "t", said knots and angles at the said end points of a said curve segment and the locus of a said curve segment, establishing a range "R" of values for said parameter "t", applying said signals indicative of the said locations of said first and second knots of said first curve segment, to said compiler, applying said signals indicative of the said first and second angles of said first curve segment to said compiler, applying a signal indicative of a distinct selected value of said parameter "t" within said range "R", to said compiler to derive a signal indicative of a respective node location on said first curve segment, repeating the above by applying signals indicative of additional distinct selected values of said parameter "t", within said range "R", to derive a plurality of signals indicative of respective node locations on said locus of said first curve segment for respective distinct selected values of said parameter "t", encoding said signals derived above in a data base to represent said first curve segment accessing said data base signals, and controlling an imaging means responsive to said accessed signals to reproduce said curve.

Further disclosed is a method and system for linear interpolation of coordinate points between first and second end points, to produce coordinates on a straight line outline and where said coordinates are located on a coordinate system having a first coordinate direction and second coordinate direction and encoded in machine readable data words a radix "r", corresponding to the order of values for designated positions in said data words, involving encoding a first data word of "N" positions corresponding to the distance between the said first and second end points in the said first coordinate direction and placing said first data word into a first machine location, encoding a second data word of "M" bits corresponding to the distance between said first and second end points in said second coordinate direction and placing said second data word into a second machine location, determining the number of available positions, between the most significant position of said first data word and the most significant position of said first machine location, available for shifting said first data word in a first direction of the most significant positions of said first machine location, shifting said first data word by a maximum number of positions, equal to the said number of available positions in said first direction and the number of positions corresponding to the number of significant positions used to encode said second data word, and increasing the scale of said first data word by a scale factor related to the number of said positions shifted, deriving a third data word indicative of said second data word in said second machine location divided into said first data word shifted according to step d), encoding data words indicative of the coordinate of said straight line in said second coordinate direction, for respective ones of said data words encoded according to step f) encoding a multiple of said third data word, which are related to a respective coordinate in said first coordinate direction, on said straight line, reducing the scale of said multiples of said third data words above, to the scale of the first data word established prior to the above said shifting and encoding said third data words produced above with respective coordinates in said second coordinate direction to produce said coordinates on said straight line.

Further disclosed is encoding data representing knots on an outline defined relative to a coordinate plane and for decoding said encoding data for use in a display process to produce images of said outlines represented by said encoded data by selecting sets of coordinates on said outline, to represent said knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order, the encoding including encoding a complete information set of data providing a control code indicative of either i) the coordinate locations of said knots or ii) a knot's direction relative to others of said knots or iii) a predetermined shape of said outline between a pair of said knots or iv) data indicative of the shape of said outline at a knot, or v) providing data indicative of the coordinate distances between adjacent knots, decoding said complete information sets in a decoding order related to said data order responsive to said complete information set being indicative of the coordinate distances between adjacent knots, producing an image of a smooth continuous curved outline or a straight line between said adjacent knots or, responsive to said complete information set being indicative of a said control code, as set forth in i), ii), iii), or iv), producing an image of a smooth continuous outline or a straight line according to the said coordinate locations of said knots relative to adjacent knots in said successive knot order or producing an image of said outline being smooth at respective knots or being sharp and forming cusps at respective knots.

Further disclosed is encoding data representing knots on an outline loop defined relative to a coordinate plane, for producing a display image of said outline and decoding responsive to the interrelationship of said knots on said outline loop, and imaging said outline loop responsive to said decoded data involving selecting sets of coordinates on said outline loop, to represent said knots, establishing a successive order of said knots, encoding said knots in a data order indicative of said knot order, encoding a complete information set of i) data indicative of the coordinate distances and interknot angles between adjacent knots, comparing the relative positions of successive knots to at least a first interknot criterion, responsive to said step d) of comparing, i) producing a first indication that a set of said successive knots is within said criterion, or ii) producing a second indication that a set of said successive knots is outside said criterion, and i) responsive to said first indication imaging said outline loop in the form of a smooth continuous curve, or ii) responsive to said second indication, imaging said outline loop in the form of a straight line, between said set of successive knots.

Further disclosed is encoding and accessing a single data set of solution values functionally related to and representing the solution set to at least two domains of a variable, involving defining a single data set of solution values functionally related to a first domain of a variable and to a second domain of a variable, arranging said data set of solution values in an order related to said first domain and said second domain, accessing said data set of solution values relative to respective values in said first domain to derive at least a part of said solution set to said first domain, and accessing said data set of solution values relative to respective values of said second domain to derive at least a part of said solution set to at least said second domain.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a shows a set of knots (i.e. Z_a, Z_{a+1}, Z_{a+2}, . . .) forming the skeletal outline of a master encoded character.

FIG. 1b shows the closed outline loops with reference to a character.

FIG. 1c shows curve segments Z_{a-1}, Z_a, Z_a, Z_{a+1}, and curve Z_{a+1}, Z_{a+2} and the relationships of the deviance angles θ and ϕ, at knot Z_a and Z_{a+1}.

FIG. 1d and FIG. 1e shows in greater detail the deviance angles of the curve segment Z_a, Z_{a+1}, at the respective entrance and exit knots, as functions of the interknot angle (B) and the entrance and exit angles, and .

FIG. 2 shows the relationships of the knots, tangent angles and angles and to a curve, for the purpose of explaining the Hermite interpolator.

FIG. 3 shows a master encoding grid as may be used in the preferred embodiment, at a normalized size, for encoding a character or symbol such as the character G shown in FIG. 3, as a master encoded character, at a normalized size.

FIG. 4 shows the manner a look-up table may be arranged so access in one direction would provide a value equal to T_2, as explained herein, and in the opposite direction, a value of T_3, as explained herein.

FIG. 5 shows the angular relationships between a set of knots Z_a, and Z_{a+1} when a sharp knot or cusp is to be produced.

FIG. 6a shows the angular relationships at a set of knots when a knot between a straight line and a curve is desired to be smooth.

FIG. 6b shows the angular relationships at a smooth knot, and between a curve line and a straight line.

FIG. 7a shows the angular relationships at a knot between a curve line and straight line, forced by a control code to override a default command code, which otherwise would produce the results shown in FIG. 7b.

FIG. 8 shows the angular relationships about a set of knots Z_a and Z_{a+1} when it is desired that a smooth continuous curve pass between the knots.

FIG. 9 shows a character as may be produced according to the principles of the invention.

FIG. 10 illustrates in block diagram a general type of system with which the method of this invention can be practiced.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As stated in the summary, the object of this invention is to generate a series of display signals, representing nodes describing the locus of a smooth continuous curve at a desired size, from a normalized curve encoded as a set of encoded knots. Normalized is used in its general and ordinary meaning to denote a norm or standard size. However, as would be apparent to those skilled in the art, the displayed curve, described in terms of display intercept coordinates (RRU's) is dependent upon the resolution of the display, and the rate or relationship between the number of raster resolution units (RRU's) at a given display resolution to the dimensionless resolution units (DRU's) in which the curve is encoded at its normalized size and on the normalized grid. The normalized encoded curve may also be thought of as a master which is encoded at a master size relative to the master encoding grid which may have any suitable coordinate system and which after scaling, may be used to generate the encoded data representing display intercepts in raster units, at a given raster resolution for any desired display size character. As the inventive concepts disclosed herein are used in the typesetting industry to produce typeset composition containing characters having curved outlines in conformance to the highest graphic standards, scaling starts with a determination of the desired size of the character in any chosen system of measurement. In the preferred embodiment, character size is expressed in printer's points (351.282 micrometers/point or Ø.Ø1383 inches/point). It being understood, however, that the invention can be used in connection with other units of measurements and with applications outside the printing or typesetting industry, without deviating from or changing the inventive concepts shown herein. The invention, as described herein is with reference to the printing industry, where the master encoding grid is made synonymous with a dimensionless encoding grid in the form of a typesetting M^2. This is the application of the preferred embodiment of the invention and discloses the best mode of using the invention.

The problem solved by this invention may be best considered by viewing FIG. 1a which shows a series of data encoded knots (Z_{a-1}, Z_a, Z_{a+1}, Z_{a+2} . . .) on a dimensionless encoding grid having coordinates in the X and Y axial directions, with the X direction coinciding with a zero degree ($0°$) reference angle. It should be understood, however, that any system of coordinates can be used with any reference angle chosen without changing the manner in which the inventive concepts are used.

As shown in FIG. 1a, a number of knots Z_{a-1}, Z_a, Z_{a+1}, Z_{a+2}, Z_{a+3} inclusive to Z_{a-n} represent an outline loop which may be smooth and continuous over a series of such knots or continuous without being smooth over a series of such knots or a combination of the foregoing. As stated, the knots represent the skeletal outline of a predetermined normalized or master size character or symbol (hereinafter referred to as master size character), on a juxtaposed dimensionless encoding grid where the coordinates have dimensions of Dimensionless Resolution Units (DRU's). In the case of the encoded character, the master size is with reference to the normalized encoding grid and the area within the grid. The interknot angles between the knots, with reference to the reference angle, are shown as generally denoted by "B" and particularly as B_{a-1}, B_a, B_{a+1} and so on for the interknot angles at respective knots Z_{a-1}, Z_a, Z_{a+1} and so on. FIG. 1a shows a skeletal outline as may be typically used for symbol wherein all the knots Z_{a-1} through Z_{a-n} on the symbol outline are arranged on a closed outline loop. This relationship in its simplest form could be shown by the knots for the outline of an O or D, encoded with two such closed outline loops, for the exterior closed outline loops 11 and 15 and one for the interior closed outline loops 13 and 17 respectively, as shown in FIG. 1b.

As shown in FIG. 1a, a direction of progression of the curve outline is chosen with reference to an defined by the order of the knots around the outline. That progression of the curve locus and order of knots is shown by numeral 19 in FIG. 1a. The chosen order of knots defining the said progression, (i.e. Z_{a-1}, Z_a, Z_{a+2} .... Z_{a-n}) establishes an outline loop of knots. That outline loop may be a closed outline loop which ends upon itself, as shown in FIG. 1b, by closed outline loops 11, 13, 15 and 17. As will be explained below, a compiler functioning according to a parametric cubic polynomial is used to generate signals indicative of nodes which are the coordinates of locations on the locus of a smooth continuous curve between the knots. The order of the knots, defines an outline loop and the respective order of the nodes by their locations relative to the knots and to each other on the outline loop, as would be apparent to one skilled in the art. As explained below, the data representative or indicative of these knots and nodes are encoded in a data order indicative of the order of the knots and nodes on the outline loop. This data order establishes a data loop. As further explained below, the data loop may be designed to close upon itself so that the ending data location for the data loop is the starting data location where data was accessed therefrom in the encoding process and forming a closed data loop corresponding to the closed outline loop.

As stated above, the knots Z_a, Z_{a+1}, etc., may be encoded in the Cartisian coordinate system as X-Y points, using as a reference the normalized encoding grid, or may be encoded in any other system of coordinate points. The outline between the knots is not encoded initially as it will be represented by a generated series of nodes and which will represent the smooth continuous curve locus of the outline, according to the principle of the invention. The display intercept values for the nodes on the curve locus, at a predetermined display size, are related to the encoded knots on the dimensionless encoding grid shown in FIG. 1a by a parametric cubic polynomial relationship. Since the invention is used in a two-dimensional system, the parametric representation represents the curve locus of such nodes Z(X,Y) independently as a third order polynomial function of a parameter "t" which is independent of the encoding grid coordinates. In the preferred embodiment, the parametric cubic polynomial is shown in a Hermite form, it being understood that those skilled in the art can use other forms for defining the polynomial such as the Bezier form, defined in "Fundamentals of Interactive Computer Graphics", referred to in the foregoing, and to which the improvements of this invention are applicable.

The parametric representation of a curve is one for which X and Y are represented as a third order (cubic) polynomial relationship of a parameter "t" where:

1.1 $x(t) = a_x t^3 + b_x t^2 + c_x t + d$

1.2 $y(t) = a_y t^3 + b_y t^2 + c_y t + d$

The Hermite representation of the parametric cubic polynomial uses the coordinate positions, of the knots, and the tangent angles at the knots, such as Z_a, Z_{a+1}, etc. The Bezier representation uses the positions of the curve's end points and two other points to define, indirectly, the tangents at the curve's end points. The improvements of this invention shown herein are applicable to any representation by the parametric cubic polynomial which uses the position of the curve's end points and the tangent angles of the curve at the end points, directly or indirectly. For sake of explanation, only the Hermite form will be discussed.

As shown in FIG. 2, given end points P_1, P_4 and the respective tangent vectors R_1, R_4 at the two end points P_1, P_4 and along the smooth continuous curve segment 18, a cubic parametric polynomial relationship between a parameter "t" and the locus of a curve segment 18, between a pair of end points, P_1, and P_4, may be represented as the following relationships below.

2.1 $x(t)= P_{1x}+(3t^2-2t^3)(P_{4x}-P_{1x})+t(t-1)^2R_{1x}+t^2(t-1)R_{4x}$

2.2 $y(t)= P_{1y}+(3t^2-2t^3)(P_{4y}-P_{1y})+t(t-1)^2R_{1y}+t^2(t-1)R_{4y}$

where (P_{1x}, P_{1y}) (P_{4x}, P_{4y}) are the coordinate values at P_1 and P_4 respectively, and (R_{1x}, R_{1y}) and (R_{4x}, R_{4y}) are the tangent values at P_1 and P_4 respectively, with respect to a straight line between P_1 and P_4 thereafter called entrance and exit angles, respectively.

Cubic curves as a minimum are used, as no lower order representation of curve segments can provide continuity of position and slope at the end points where the curve segments meet, and at the same time can assure that the ends of the curve segment pass through specific points.

The derivation of the Hermite parametric cubic polynomials are shown in "Fundamentals of Interactive Computer Graphics" and the manner of using such parametric cubic polynomials to define the points along a curve are further discussed in T_EX and METAFONT referred to in the foregoing.

The Hermite form of the parametric cubic polynomial is as stated is a series of curves as shown by Knuth in Chapter 2 in T_EX and METAFONT and which is written in Euler notation as

$$3.1 \quad Z(t) = Z_1 + (3t^2-2t^3)(Z_2-Z_1) + rt(1-t)^2\$_1 - st^2(1-t)\$_2$$

$$3.2 \quad \$_1 = e^{i\theta}(Z_2-Z_1); \quad \$_2 = e^{-i\phi}(Z_2-Z_1); \quad 0 <= t <= 1$$

and, where r and s are positive real numbers. Equations 3.1, 3.2 define a curve having directions represented by the deviance angles θ and ϕ at Z_1, Z_2 respectively.

The relationship shown in 3.1, 3.2 may be encoded into a compiler designed to process input data related to the knot locations, the angles of the curve segment at its end points, and then for separate selected values of a parameter "t" to produce signals indicative of node locations on the locus of the curve segment. The compiler is shown at the end of the specification.

As stated above, the Hermite form of the parametric cubic polynomial is used in the preferred embodiment of the compiler but the principles of the invention can be used with any other cubic polynomical using the directions of the curve at end points of the curve and the end point locations.

Assuming a curve direction for a given knot order from knot to knot, and in particular, from knot Z_1 to knot Z_2, with knot Z_1 being the entrance knot for curve segment Z_1, Z_2 (hereafter curve segments will be defined by the respective segment and knots such as "curve Z_1, Z_2") and knot Z_2 being the exit knot for curve Z_1, Z_2, then Θ is the angular direction of the curve Z_1, Z_2 at entrance knot Z_2, and Φ is the direction of curve Z_1, Z_2 at exit knot Z_2. In the preferred embodiment, the interknot angle (B) made by the straight line from knot Z_1 and Z_2, is defined in terms of a reference angle given for the normalized encoding grid. Also, the angles θ and ϕ of the curve are related to that same reference angle. Therefore, the interknot angle expressed below as B and the angles of the curve at the entrance knot, defined below as θ and the angle of the curve at the exit knot, defined below as ϕ, are all defined with regard to a reference angle.

As further explained below, according to the inventive principles, deviance angles Θ and Φ, shown used in equation 3.1 and 3.2, are the curve entrance and exit angles θ, ϕ, respectively, defined with regard to the interknot angles B and applied to the compiler in the form of the parametric cubic polynomial, as shown in equation 3.1.

In explaining the invention, $\dot{\theta}$ and $\dot{\phi}$ are used to identify the entrance angle of a curve segment at a first knot end point and the exit angle made by that same curve segment at a successive second knot end point, in the knot order. The first and second knots define the entrance and exit knots of the curve segment, with regard to the order of knots and the outline loop, as explained below. However, $\dot{\theta}$ and $\dot{\phi}$ are defined relative to a reference angle "q" on the master encoding coordinate grid. Θ and Φ are the entrance angle and exit angle in the cubic parametric polynomial of 3.1 and 3.2, defined relative to an interknot angle B between the entrance and exit knots (i.e. in the preferred embodiment, $\Theta = \dot{\theta} - B$; $\Phi = B - \dot{\phi}$). The preferred embodiment uses a process of defining the entrance angle $\dot{\theta}$ and exit angle $\dot{\phi}$ in terms of the interknot angles on the outline loop, and with respect to a reference angle and uses the definition of the entrance and exit angles shown as Θ and Φ when applying the angles $\dot{\theta}$ and $\dot{\phi}$, at the respective entrance and exit knots, to the compiler, as based on and as required by the derivation of the cubic parametric polynomial, described herein. However, the angles Θ and Φ could be derived directly from the interknot angles B or precomputed from the relationship of the outline loop knots and accessed directly without first deriving $\dot{\theta}$ and $\dot{\phi}$ and without deviating from the principles of the invention.

The parameter "t" of 3.1 is allowed to vary over a defined range as further explained below, and for each discrete selected value of t, a discrete node on the locus of the curve between the entrance and exit knots and defined by the parametric cubic polynomial is generated by the compiler. The nodes would be the coordinate location of points on the locus of the curve described by equation 3.1 for each selected value of "t" and where knots Z_1 and Z_2, and the angle of the curve at those knots, given as δ and ϕ, derived above, was specified. The derivation of δ, B, ϕ, Θ, and Φ of "t" and their relationship according to the principles of the invention are further explained and shown below.

It should be noted, however, that the form of the Hermite interpolator used in the preferred embodiment imposes an opposite sign for Φ than that shown in T_EX and METAFONT shown in Knuth.

It should also be noted that the deviance angles Θ and Φ representing the divergence between the straight line angle interknot angle (B), as used in the cubic parametric polynomial of 3.1, 3.2.

"r" and "s" affect the curve velocities, as described below and the length of the curve between its respective end points (i.e., curve Z_1, Z_2 between Z_1, Z_2). "r" and "s" are velocities at Z_1, Z_2 respectively, a large velocity value meaning the curve direction changes slowly while small values indicate the curve undergoing more pronounced directional changes [small values of r and s will then have less influence on the value of x(t) or y(t)]. The velocities, r and s, in T_EX and METAFONT are represented as

4.1 $$r = \left| \frac{2*\sin\Phi}{(1+|\cos\psi|)\sin\psi} \right|$$

4.2 $$s = \left| \frac{2*\sin\Theta}{(1+|\cos\psi|)\sin\psi} \right|$$

4.3 $$\psi = (\Theta + \Phi) / 2$$

Considering the effect of r and s on the curve locus defined by the nodes, produced through the cubic polynomial relationship, the values of r and s may be limited to control the direction of the curve from the entrance knot to the exit knot. In the preferred embodiment, r and s are limited to the values of 0.1 to 4.0. However, these values of r and s could be changed without departing from the principles of the invention.

As discussed in the foregoing, the system shown therein for using the relationship of the points along the smooth curve in T_EX and METAFONT have disadvantages which are eliminated by this invention which will become apparent by reading the following explanation.

As explained above, in using the parametric cubic polynomial relationship to define the nodes along a smooth curve, T_EX and METAFONT start with a circle approximation rule and then must make adjustments to produce a smooth continuous curve between given points. In this invention, those disadvantages are eliminated by the invention described in the following.

In the preferred embodiment, the sign of Φ is reversed relative to the angle rotation used in T_EX and METAFONT.

The principles of this invention as applied to the preferred embodiment, may now be particularly seen with reference to FIG. 1a. As stated above, a skeletal outline is described by a progression of a series of knots in the order of z_a, z_{a+1} . . z_n, z_{a-1}, which defines a closed outline loop about the outline of the character or symbol. The knots are encoded as coordinate points in a closed data loop, representing the closed outline loop. As stated, the object of the invention is to produce a series of nodes representing display coordinates on the locus of a curve between each of the knots, the curve being smooth and continuous. However, as will be shown, the principles of the invention can be modified so a series of points describing straight lines between knots can be generated and smooth continuous curves can be generated between knots which are interspersed with straight lines. In addition, cusps can be formed between smooth continuous curve and/or straight lines.

The smooth continuous curve is produced through the parametric cubic polynomial relationship described above. In using the invention, the following principles are applied. The data loop may be entered at the data values representing a knot, Z_a for example, and the angular relationship of the knot (Z_a) referenced to a preceeding knot (Z_{a-1}) and to a succeeding knot in the loop analyzed. The analysis may then proceed in a clockwise direction around the loop which may be considered in the forward direction. However, as stated, the analysis can proceed in a counter- clockwise or backward direction with the direction being used to denote or indicate other values, such as color, or other characteristics as may be needed. As will be understood, the directions used herein are chosen for explanation and do not limit the inventive principles.

FIG. 1a represents a series of knots Z_a, Z_{a+1}, Z_{a+2} --- Z_{a+n}, Z_{a-1} arranged in a closed outline loop, encoded relative to a master encoding grid and partially defining, in skeletal form, the points on a closed outline loop, such as outline 11, 13, 15, or 17, shown in FIG. 1b. The interknot angles, the angles from knot to knot (i.e. from knot Z_{a-1} to knot Z_a) are denoted generally by the letter

"B" with a subscript reference indicating that the angle is formed by a straight line from a respective knot, B_{a-1} for example, to a successive knot B_a in the outline loop. The terms "preceding" and "successive" can be used with reference to the defined order of knots in the outline loop, i.e. either clockwise or counterclockwise, as the case may be. In FIG. 1a, the knot angles B are shown as B_a, B_{a+1}, B_{a+2}, and so on for respective knots.

The manner of applying the cubic parametric polynomial compiler in the preferred embodiment to define nodes between the knots along the locus of a smooth curve utilizes the deviance angle θ at the curve entrance knot and the deviance angle Φ at the curve exit knot. The deviance angles θ and Φ may also be referred to as entrance and exit angles.

According to the principles of the invention, and assuming a smooth and continous curve segment is desired to be developed between a first knot Z_a and a second knot Z_{a+1}, for the curve Z_a, Z_{a+1}, shown as numeral 21, in FIG. 1c, then the inventive principles may be used to generate a series of signals representing the display coordinates for the nodes along the locus of the smooth continuous curve 21 as follows and similarly for the curves between others of respective pairs of knots. The data encoding of the knots representing each of the closed outline loops may also be thought of as a loop, or closed data loop, indicative of and representing the physical arrangement of the knots in the closed outline loop about the character or symbol outline. As stated, the outline loop and the data loop therefore, may be thought of as an order of knots in the loop path and related to a predetermined loop direction for such order (clockwise or counter- clockwise, for example). Within that progression, and for the respective outline loop direction, it can be easily seen that each knot (i.e. Z_a) represents an exit point for the curve segement of the outline loop in the knot order shown by the direction of arrow 20, from a preceding loop knot (i.e. Z_{a-1}) and at the same time, the entrance point for the curve segment from that knot (i.e. Z_a) to a successive knot (i.e. Z_{a+1}). The nodes, generated as explained below are given an order in the outline loop related to the order of knots on the outline loop and the encoding for the nodes is similarly arranged on the data loop in the order of the knots.

In explaining the invention, the convention used for identifying a curve part of the outline loop between knots is to refer to it by its knot end points, (i.e. curve part 21 is curve Z_a, Z_{a+1}). Similarly, a convention is used to identify a curve entrance and exit angle as explained below.

The entrance angle ϕ for curve Z_a, Z_{a+1} (between knots Z_a and Z_{a+1}), according to our convention, would be the angle represented by the first derivative of the curve Z_a, Z_{a+1} at knot Z_a and the exit angle φ would be the angle represented by the first derivative of the curve segment at the next successive knot Z_{a+1}.

As would be understood, where a smooth continuous curve is desired to pass through a knot, (i.e. Za) then the entrance angle ϕ, at a knot would be the same as the exit angle φ at that same knot for the preceding curve segment Z_{a-1}, Z_a.

In explaining the principles of the invention, the entrance angles ϕ and exit angles φ for curve segments starting and ending at knots are defined for the respective knots according to the following convention. The curve segments may be thought of as having an entrance angle θ at the knot where the outline loop, in the defined progressive order of knots, enters a respective curve segment (i.e. curve Z_a, Z_{a+1}) forming an entrance angle θ_a at that entering knot, and an exit angle ϕ at the next successive knot in the loop where the loop exits curve segment Z_a, Z_{a+1} forming exit angle ϕ_a at knot Z_{a+1}. In the convention chosen, the entrance and exit angles (θ_a, ϕ_a) for a curve segment (Z_a, Z_{a+1}) of the loop are referenced to the entrance knot (Z_a). The entrance angle, θ_a, and the exit angle, ϕ_a, therefore have a subscript reference to the entrance knot Z_a, but refer to the curve segment of the loop and the angle that curve segment makes at a first knot Za where the loop enters the curve Z_a, Z_{a+1} and the angle at a successive knot (Z_{a+1}) relative to the outline loop direction where it exits the curve Z_a, Z_{a+1}. The entrance angle, θ_a, is then the angle the loop makes as it passes through knot Z_a, enters curve Z_a, Z_{a+1}, and continues on to knot Z_{a+1}. The exit angle, ϕ_a, is the angle the loop makes as it passes through knot Z_{a+1}, exits curve Z_a, Z_{a+1}, enters the next successive curve Z_{a+1}, Z_{a+2} and continues on to the next subsequent exit knot, Z_{a+2}. In summary, the entrance angle , θ, and exit angle, ϕ, according to the convention chosen to explain the principles of this invention, refer to a curve segment of a loop outline between two knots such as Z_a and Z_{a+1}, the entrance angle θ_a being the tangent angle or first derivative the outline loop makes as it enters curve Z_a, Z_{a+1} at preceding knot end point Z_a in the outline loop direction, and the exit angle, ϕ_a, the tangent or first derivative of the outline loop it makes as it exits that curve Z_a, Z_{a+1} at knot end point Z_{a+1} and enters the next successive curve Z_{a+1} Z_{a+2}, in the outline loop direction. As can be seen, the exit angle, ϕ_a, for the curve Z_a, Z_{a+1} is the same angle as the entrance angle θ_{a+1}, for the next successive curve Z_{a+1}, Z_{a+2}, in the outline loop direction. Similarly, the entrance angle, α_a is the exit angle, ϕ_{a-1} for the preceeding curve Z_{a-1}, Z_a. It will be understood by those skilled in the art that these conventions can be changed without changing the principles of the invention.

Whereas Knuth uses the rule that a smooth continuous curve locus between points, such as from Z_{a-1} to Z_a to Z_{a+1}, must take the direction of a circle, the invention herein avoids that rule and the problems created thereby by using an average of the interknot angles (B) relative to a knot to define the respective knot entrance and exit angles, α and ϕ respectively, and thereby θ and Φ respectively.

For example, in FIG. 1c, for the curve Z_a, Z_{a+1}, shown as numeral 21, the entrance angle α_a at knot Za of the curve Z_a, Z_{a+1}, for example, is related to the average of the interknot angles B_{a-1} (from the preceeding knot Z_{a-1} to knot Z_a) and B_a (from Z_a to the succeeding knot Z_{a+1}). That average angle of the outline loop at any knot Z is a;so expressed as α when referring to the entrance angle at a knot and into a curve segment and ϕ when referring to the exit angle from a knot and out of a curve segment. In the case of knot Z_a, the average entrance angle would be α_a for the curve Z_a, Z_{a+1} (shown by numeral 21), proceeding from Z_a to Z_{a+1} in the order shown by arrow 20 and ϕ_{a-1} for the average exit angle for the curve Z_{a-1}, Z_a (shown by numeral 23), proceeding from Z_{a-1} to Z_a in the order shown by arrow 20.

The angles α or ϕ are always referred to as entrance and exit angles respectively herein, but may or may not be average angles or not depending on the application of each, as explained herein.

The invention is explained with reference to the example of curve Z_a, Z_{a+1}, wherein Z_a is the entrance knot and Z_{a+1} is the exit knot, it being understood that the same analysis would apply to other curve segments either adjoining or further remote from curve Z_a, Z_{a+1} and having respective entrance and exit knots.

In using the compiler to generate the nodes along a smooth continuous curve, the encoded data loop representing the knots along the closed outline loop may be entered at any set of data representing any knot Z, for example, designated to be the entrance knot and the average angle determined by proceeding in the chosen loop direction using the interangular relationships of a knot to its related knots in the loop, to determine the average angles ϕ and ψ at such related knots. In the preferred embodiment, these related knots are adjacent knots to the next successive knot to the entrance knot.

In the preferred embodiment, the inventive principles of generating the nodes on the smooth continuous curve locus, starts with a first average angle, determined for the knot coordinate successive to the data loop entrance knot, and which is represented by the data residing at the location in the closed data loop where that data loop was entered. The interknot angle for the entrance knot is then saved and used at the completion of the loop analysis to determine the average entrance and exit angles at that entrance knot when the outline loop analysis reaches that entrance knot in the closed outline loop knot. Where the data loop entrance knot is Z_{a-1}, its average angle would be determined using the preceding interknot angles B_{a-2} and B_{a-1} for related knots Z_{a-1} and Z_{a-2}.

Following the above, the average angle $\grave{\phi}_a$ and exit angle ϕ_{a-1} at knot Z_a is the average of B_{a-1} and B_a and expressed as

$$\grave{\phi}_a = \frac{B_{a-1} + B_a}{2} = \phi_{a-1}$$

The average exit angle ϕ_a and entrance angle $\grave{\phi}_{a+1}$ at knot Z_{a+1} is the average of B_a and B_{a+1} and expressed as

$$\phi_a = \frac{B_{a+1} + B_a}{2} = \grave{\phi}_{a+1}$$

As shown, the average entrance angle $\grave{\phi}$ for any curve segment is the average of the interknot angles at the respective curve segment knot and at related knots, (i.e. the preceding knot in the outline loop) and the average exit angle ϕ is the average of the interknot angles at the respective curve segment exit knot and at related knots (i.e. the next successive knot in the outline loop), as shown above.

The parametric cubic polynomial compiler may then be employed to relate the entrance and exit angles $\grave{\phi}$, ϕ for the respective entrance and exit knots to a series of nodes describing the locus of a smooth curve between the respective entrance and exit knots (i.e. Z_a, Z_{a+1}). For the example above, the knots are Z_a, Z_{a+1} and the respective entrance and exit angles are $\grave{\phi}_a$ and ϕ_a for curve Z_a, Z_{a+1}.

The curve velocities r and s are related to the deviance angles θ and Φ, as set forth above and as used in equation 4.1, 4.2, 4.3. As stated in the foregoing, θ is the deviance between the average entrance angle, for example, θ_a for curve Z_a, Z_{a+1}, at an entrance knot Z_a and the interknot angle B_a at that entrance knot Z_a. Similarly, Φ is the deviance between the average exit angle, for example, at the exit knot, Z_{a+1}, for the curve Z_a, Z_{a+1} and the interknot angle B_a at that entrance knot Za.

The relationships between θ_a, B_a, ϕ_a, Θ_a and Φ_a may be more clearly seen in FIGS. 1d and 1e for knots Z_a and Z_{a+1} respectively.

As a reminder, it should be remembered that the angles, Θ and Φ are the tangents to the locus of the curve represented by the nodes generated using the cubic parametric polynomial compiler with respect to the respective interknot angles.

The coordinate values of Z_a, Z_{a+1}, used through the parametric cubic polynomial compiler to generate the node values are the scaled intercept values given in RRU's, derived from the master encoded values of the knots, in DRUs. For example, assuming an encoding grid shown as an M^2 in FIG. 3 and defined as 864 X 864 DRU's between master encoding grid (x,y) coordinates 592, 736; 592, 1600; 1456, 1600 and 1456, 448 (wherein x,y points 592, 736 are defined as relative 0,0, relative to an x, y offset of 592, 736 respectively) and wherein the encoding grid is defined as 2047 by 2047 DRU's.

In the preferred embodiment, the universe of the master encoding grid comprising the M^2 is 32768 X 32768 DRU's and the offset which positions the origin of the M^2 can be positioned anywhere in that universe. In the preferred embodiment, the x and y offsets and shown in FIG. 3.

The x,y coordinates of the intercept locations for knots Z_a at the displayed size in RRU's may be derived prior to generating the nodes by scaling, using the following conversion factor (CF), for the preferred embodiment.
Where:
"P" in the desired display size in points per M^2 (Pt/M^2),
"Res" is the ratio of micrometers per point (uM/Pt) and serves to convert the display size from points to metric units;
"RRU/MM" is the display resolution in Raster Resolution Units per Micrometer;
M^2/DRU is the inverse of the encoding grid resolution, in DRUs per M^2;
and

$(P)*(Res)*(RRU/MM)*(M^2/DRU) = (CF)*(RRU/DRU)$
For Master Coordinate $Z_n(X_n, Y_n)$,
(X_n DRUs) (CF_x RRUs/DRU) = X_n RRUs, and
(Y_n DRUs) (CF_y RRUs/DRU) = Y_n RRUs

The value of the parameter t may be derived from the respective curve segment interknot distance $Z_d = | Z_{n+1} - Z_n |$ given after scaling in RRUs, as described below. The generated coordinates for the nodes are expressed in RRU's permitting run length encoding of the display outline coordinates. Where Z_d is a non-integer, the fractional value may be discarded or rounded with redundant values eliminated.

In the preferred embodiment of this invention, the incremental value of t is related to the inverted value of the absolute difference Z_d between the entrance and the exit knots,
i.e. $t\_inc = 1/Z_d = 1/|Z_{n+1}-Z_n|$.

Zn may be easily derived from the axial difference in the X direction, [i.e. $Z_d = [(X_{n+1}-X_n)/Cosine(B_n)]$, or the axial difference in the Y direction, $[Z_d = [(Y_{n+1}-Y_n)/Sine(B_n)]$; Where X_n Y_{n+1}; X_{n+1}, Y_{n+1} are successive knots defining end points for a curve segment of the closed outline loop and Bn is the interknot angle there between).

In practice, it is better to use the larger axial value in the X or Y direction, to minimize error. In implementing the invention, the preferred embodiment limits increments of t to 1/1024. Discrete values of $T_1 = 3t^2 - 2t^3$, $T_2 = t^2(1-t)$ and $T_3 = t(1-t)^2$ (see equation 3.1, 3.2) may be stored in a look-up table for 1024 values of t in the range 1/1024 t 1024/1024.

In practice t is stored in the range of 1023/1024 because the knot end point coordinate corresponding to t = 1024/1024 or 1 is saved, avoiding the need to calculate that knot end point and providing a more reliable result.

Further, because of the relationship of T_1, T_2 and T_3, a look-up table as shown in FIG. 4, having values of T_2 starting with t=0 and ending with a value of T_2 for t=1, may be accessed in reverse order for values of T_3, as shown in FIG. 4.

The values, shown stored in a look-up table in FIG. 4, are for discrete values of t in discrete steps of 1/1024 (i.e. 0/1024 to 1023/1024). However, t is shown being inclusive from 0 to 1 for the purpose of explanation, it being understood that in the preferred embodiment, varies between 0 and 1023/1024 as the end point for T_2 1024/1024 is known.

Because the functions domain of the variable t for the solution sets $T_2 = t(1-t)^2$ and $T_3 = t^2(1-t)$ overlap, a table of values may be accessed in one data direction with respect to a first domain of variables for which the value represents a solution set. Similarly, that solution set may be accessed in an opposite data direction for a second domain of a variable.

Also, because the function $|1 + \cos\theta| \sin\theta$ is symmetric about 45 degrees, it is only necessary to store values thereof for 0 to 45 degrees in half angle steps.

The solution set of values for the functions T_2 and T_3 may be accessed in a first data direction to provide the functional solution set values for the domain t = 0 to t = 1 and in reverse order for the domain t = 1 to t = 0. Values of Sine may be stored in half angle steps between 0 and 90 degrees. Further, any derived nodes may be stored and used again where the respective curve or corresponding symbol outline loop is to be duplicated.

By forming a cumulative value of t as a multiple of the incremental value of t and applying cumulative discrete selected values of t within the parametric cubic polynomial compiler, according to equation 3.1, display intercepts represented by the generated nodes are produced which may then be used as the display coordinates for the closed loop outline at the desired display size.

As stated above, the value of θ and ϕ used in the compiler are derived, according to the principles of the invention from the average entrance and exit angles, $\bar{a}$ and $\bar{g}$ at a respective set of entrance and exit knots. The nodes which are generated using the incremental value of t to increment the cumulative value of t and by applying discrete selected cumulative incremented t values to the cubic parametric polynomial compiler to produce respective node coordinates for such discrete selected values of t.

The nodes, represent locations on the curve, which, as stated above, form an angle at the entrance knot of the curve as given by θ, and forms an angle at the exit knot given by Φ As stated, an order is chosen for the knots and the order of knots defines an outline loop of knots, the nodes being locations on the curve, between the knots also have an order defined by that knot order and by the defined outline loop. As would be understood by those skilled in the art, that order is the succession of knots and nodes encountered as one progresses along the outline loop as specified. The data for the knots and nodes, as stated above, is encoded in a data loop in that same order of knots and nodes. The encoded knots and nodes are placed in the data loop, in that order corresponding to the outline loop. Then, as one progresses in the defined order along the data loop, corresponding to the outline loop, one would encounter the encoding for the knots and nodes in the data loop in an order, corresponding to the order one would encounter the respective knots and nodes on the outline loop represented by that said encoding.

In summary, given the knot locations, and the angles of the curve at an entrance and exit knot as defined above, and given an incremental value of t, then each discrete selected cumulative value of t, as described above, applied to the cubic polynomial parametric compiler would produce respective nodes, indicative of locations along the smooth continuous curve described by the cubic parametric polynomial. The encoding for the knots and nodes would be in the same order along a data loop as one would encounter the corresponding knots and nodes along the outline loop, when proceeding in a chosen order along the outline loop.

The outline loop, when closing upon itself as shown in FIG. 1b, for example, is called a closed outline loop. The data when encoded in a data loop which closes upon itself corresponding to the closed outline loop is called a closed data loop. In this way, accessing the closed data loop, in a direction corresponding to the chosen direction along the closed outline loop will return one to the initial or starting data loop entrance location. As described below, the data loop decoding is not complete until a determination is made that the accessed location for the closed data loop is starting location point and that accessing of all the encoded data in the closed data loop has been completed.

Of course, as one skilled in the art would realize, variations of the above closed outline loop and closed data loop can be made without departing from the principles of the invention.

These node coordinate values given in Raster Units may then be used in run length or other suitable data forms to modulate a display to produce the curve at the desired size, as is well known.

The compiler according to the foregoing is shown below.

ENCODING

The novel manner of encoding the data pack, according to the principles of the invention, is shown in the Table I below, wherein p is the value of dx, q is the value of dy and Ø, 1, 2, . . . D, E, F, are bit positions in the encoded data pack. In the preferred embodiment, the bit positions are valued according to the binary number system. The Control Codes, explained below, are shown in Table II. The encoding, shown for a maximum 12 binary words of 3 nibbles, in the preferred embodiment, is used to define a control code or coordinate position for the master encoding grid. It should be understood that the size of the word and the number of nibbles used, as described below would increase to accommodate a larger universe, commensurate with a larger size master encoding grid.

The binary words are encoded in a series of nibble length data words, arranged in the order of the data loop. In this way, as will be shown below, the values of selected data words with a nibble series may be used to define the number of nibbles in a complete information set and the initial nibble or bit positions in the next successive complete information set.

A complete information set (CIS) would be the set of data words necessary to completely define the next coordinate or a control code, as shown below.

TABLE I

Case Indicated by a 1st nibble value of	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	Case	Limits	
1 - 3													0	0	q1	q0	.I.a	p=0	q=[1..3]
0									q3	q2	q1	q0	0	0	0	0	.I.b	p=0	q=[0,4..18]
4 - 7									q2	p2	p1	p0	0	1	q1	q0	.II.	p=[1..8]	q=[1..8]
8 - B					q3	q2	q1	q0	p3	p2	p1	p0	1	0	q4	p4	.III.	p=[1..32]	q=[1..32]
C - F	p6	q6	q5	q4	q3	q2	q1	q0	p3	p2	p1	p0	1	1	p5	p4	.IV.	p=[1..128]	q=[1..128]

TABLE II

Case	Definition	Override Control Code Value	Total No. of Data Words Needed incl. 1st Data Word	Purpose
Ib	end last	0	2	end of last loop
Ia	horizontal(x)	1	1+3 =4	horizontal motion
Ia	vertical(y)	2	1+3 =4	vertical motion
Ia	diagonal(x,y)	3	1+3+3 =7	diagonal motion
Ic	start loop	4	2	end/start new loop
Ib	x negate	5	2	invert x direction
Ib	y negate	6	2	invert y direction
Ib	xy negate	7	2	invert x & y direction
Ib	line sharp	8	2	linear interpolate sharp knot
Ib	line smooth	9	2	linear interpolate smooth knot
Ib	sharp	10	2	curve interpolate sharp knot
Ib	smooth	11	2	curve interpolate smooth knot

The data pack forming the closed data loop is used for encoding the axial distances in DRUs (p=dx, q=dy) between knots, and for the double purpose of identifying and accessing override control codes. These override control codes are used to speed the decoding process and reduce the requirement for encoded data describing coordinate points while offering the further option of edit commands.

The data pack override control codes may be used to override machine default command codes which would otherwise be responsive to parameters expressed within the data pack. As can be seen, the data pack offers the option of following default command codes, responsive to predetermined parameters, such as angles between knots or interknot distances, or override control codes for generating the desired series of nodes and curve locus between knots.

In the preferred embodiment, the default command codes are selected responsive to the parameters of the closed outline loop described by the interknot distances expressed within the data pack. The process of the invention described above for generating a series of nodes forming a smooth continuous curve between a set of end points would normally be used except where the distance between those end points was greater than a predetermined distance, such as 128 units for the preferred embodiment. In that case, where the interknot coordinate distances were greater than 128 units, the default command code responsive thereto would direct straight line interpolation and the formation of a series of nodes to find the locus of that straight line between the knots defining that respective coordinate distance.

Similarly, where the exterior angle formed by a line from the entrance knot to the exit knot and by a line formed from the exit knot to a successive knot is greater than a predetermined angle, such as 40° in the preferred embodiment, then a default command code responsive thereto would direct that a cusp be formed at the exit knot.

Straight line interpolation is well-known in the art. However, within the inventive scheme herein is provided an auto-scaling interpolation which provides an innovative and simpler method of linear interpolation and at the same time increases its accuracy and the precision of the closed outline loop as defined by the series of generated nodes. The auto-scaling linear interpolator is described below.

The format of the data pack shown in Table 1 is based 4 bit boundries defining data words of 4 bits each. Data from the data pack, representing discrete complete information sets is accessed in a series of data words in nibbles of 4 bits at a time with the significance of that complete information set (CIS) and the number of data words therein indicated by the value of the first nibble. The correspondence between the first data word value of a series of data words forming a CIS and the Case indicated by that first data word value is shown below.

First data word value	Case	Purpose
1 - 3	Ia	Control Code
0	Ib	Control Code
4 - 7	II	Coordinate Distance
8 - B	III	Coordinate Distance
C - F	IV	Coordinate Distance

A series of data words may be a control code as in the Cases Ia and Ib or the coordinate distances between knots, represented by the x,y incremental values between such knots in the preferred embodiment, in Cases II, III and IV.

Where the data words are nibbles, in the preferred embodiment the first nibble value of a nibble series then indicates the Case, and directs the access of a predetermined number of successive nibbles or data words within the closed data loop from the CIS and to complete the override control code, as in Case Ia or Ib or to assemble the number of data words necessary to complete the values corresponding to the coordinate distance between the next knot in the closed outline loop, as in Cases II, III and IV.

The number of nibbles or data words accessed responsive to the first nibble or data word value are the nibble or data word series necessary to form the CIS for the particular Case, after the first nibble or data word, as follows:

In Case II, one nibble or a total of 2 nibbles are required. In Case III, two more nibbles after the first nibble, or a total of 3 nibbles are required, and in Case IV, three more nibbles after the first nibble, or a total of 4 nibbles are required to provide the value of the interknot coordinate distance.

In the Cases Ia and Ib, the number of successive nibbles which must be accessed, responsive to the value of the first nibble, is ordered responsively to the Case indicated and as explained in detail below. For example, Case I may require the accessing of 3 or 6 nibbles to complete the Case Ia control code.

At the end of the data word series of a CIS, accessed responsive to the first data word value, the next successive nibble in the closed data loop would then be considered the first data word value of the next data word series and corresponding CIS. That new first data word value of the next data word series would then in a similar manner indicate the number of successive data words to be accessed to complete the completed information set for the override control code or the value of the interknot coordinate distance, as the case may be. By encoding the closed data loop on 4 bit boundries, the data with respect to control codes may be packed successively within the closed data loop with the data respecting the interknot coordinate distances and, as such, the closed data loop may serve the double function of providing override control codes as well as interknot distance data.

Table II provides a definition of the control codes, control code value, the number of nibbles including the first nibble to complete the control code instruction and the purpose of the control code.

Further, as shown in Table I, and as stated above, a first nibble value of 1 to 3 is indicative of Case Ia and with that first nibble value indicating the particular control code value for case Ia, either 1, 2, or 3, and the number of subsequent nibbles to be accessed for the CIS forming that particular Case Ia control code.

As shown in Table II, 3 additional nibbles are required for a total of 4 nibbles, including the first nibble, to complete the CIS responsible to a control code value 1, 3 additional nibbles for a total of 4 nibbles are needed to complete the CIS responsive to a control code value of 2 and

6 additional nibbles for a total of 7 nibbles are needed to complete the CIS responsive to a control code value of 3.

Where the first nibble value of a CIS is zero, then Case Ib is indicated, as shown in the Table I, and the access of the next successive nibble directed for completion of the Case Ib instruction. In Case Ib, 4 is added to that next nibble value to obtain the control code value for case Ib. The control code values for Case Ib are shown in table II with their corresponding purposes.

In summary, a first nibble value of Ø, or 1 to 3, indicates Case Ia or Case Ib as shown above, and directs the accessing of a predetermined number of nibbles in the closed data loop successive to the first nibble, to form the CIS for that Case and which is then used to determine the control code value which in turn directs the processor. The next nibble subsequent in the order of the closed data loop to the last nibble of the previous nibble series corresponding to a CIS then becomes a new first nibble value and is used to indicate either an override control code or interknot coordinate distance. Further, and as shown below, where the first nibble bit as shown above indicates a Case II, the ordering of one more nibble for a total of 2 nibbles is required to complete the CIS and to provide the incremental coordinate distance. For Case III, 2 more nibbles for a total of 3 nibbles are required to complete the CIS for the incremental coordinate distance. For Case IV, 3 more nibbles for a total of 4 nibbles are required to complete the CIS for the incremental coordinate distance for code 4. Then the next successive nibble in the closed data loop after the CIS would be the new first nibble value indicative of case Ia, Ib, II, III, or IV, as the case may be, leading to an indication of the number of successive nibbles needed to complete the CIS to complete the control code or incremental coordinate distance.

For the override control code Case Ia, where the next successive knot in the closed outline loop is to be defined by Case Ia, control code values 1, 2 or 3, as shown in Table II, then, the first nibble value will have a value of 1, 2 or 3 (thereby indicating override control code Case Ia), and with the control code value being indiated by the specified first nibble value (i.e. 1, 2, or 3). The number of successive nibbles to be accessed to form the CIS for that Case Ia control code are indicated by the value of the first nibble value. Where the value of that first nibble value is 1, then as shown in Table II, the next three nibbles in the closed data loop are accessed and used to denote horizontal or motion in the X direction with the next knot X coordinate given by the next three nibbles, completing the nibble series necessary to form the Completed Information Set for that control code.

Where the value of that 1st nibble is 2, then as shown in table II, a vertical motion in the Y direction is indicated with the next three nibbles in the closed data loop being accessed, to complete the nibble series necessary to form the CIS and indicating the Y coordinate value of the next knot.

Where the value of that 1st nibble is 3, then the next six nibbles in the closed data loop are accessed to complete the nibble series and necessary to form the CIS and indicating the next knot, diagonally related to the immediate knot, and with the X,Y coordinates therefore given in each of the next 3 nibbles.

In the preferred embodiment, the least significant bit of the control codes for Case Ia, namely control codes 1, 2, and 3 is used to provide a direction instruction for new X, Y or X,Y coordinate values relative to the preceding knot in the closed outline loop. That relative direction between the new knot position and the preceding knot is then followed when locating the positions of successive knots corresponding to the information in a Case II, III or III instruction indicating the incremental coordinate distance. As will be seen below, the direction may also be changed by a Case Ib control code 5, 6 or 7 which would negate the established X, Y or XY direction.

In summary, in the closed outline loop new knot coordinates as indicated by Case Ia, control code values 1, 2 or 3, shown in table II, would be located in a direction consistent with a previous X and Y direction instruction, unless the least significant bit of the first nibble value for the CIS indicates a change in direction, as in Case Ib, control code values 5, 6 and 7.

In summary, the first data word value is the value of the first data word of a series of data words forming the Completed Information Set (CIS) of the closed data loop, indicating a override control, code as in case Ia, for first nibble values 1, 2 and 3, or as in Case Ib, for value Ø, or the incremental coordinate distances as for first nibble values 4-F, for cases II, III or IV.

Then, as stated above, if the 1st data word value, in a nibble size data word series is a zero, then control code case Ib is denoted. Case Ib, directs the access of another nibble of 4 bits in the closed data loop and, if that nibble is not equal to Ø, its value is added to value 3 to obtain the proper control code, as shown in Table II. In this way, a total value of control codes 0 and 4 to 18 may be defined. The meanings of each of the control codes having values 4-11 is shown in Table II.

If the control code value for the additional 4 bits is zero, the end of the last loop is indicated (i.e. bits 4-7 are 0 value).

Code 4 indicates the start of a loop.

Codes 5, 6 and 7 provide direction information for the next knot in the closed outline loop relative to the preceding knot.

Codes 8, 9, 10 and 11 are editing override control codes, which override the default command codes.

The editing override control codes are used to override the default command codes, which would normally be responsive to and result from a machine interpretation of the data pack values for cases II, III and IV.

Code 8 directs Linear Interpolation Sharp Knot. As shown in FIG. 5, it may be used to force the exit angle at a knot (i.e. ϕ_a at knot Z_{a+1}) for curve Z_a, Z_{a+1}, to be equal to the interknot angle B_a at the entrance knot, Z_a of that same curve Z_a, Z_{a+1}. As shown in FIG. 5, Code 8 forces the curve Z_a, Z_{a+1}, at knot Z_{a+1} to have the same exit angle at the exit knot (Z_{a+1}) as the interknot angle B_a at its entrance knot Z_a and produces a sharp cusp at Z_{a+1}. To complete the cusp at Z_{a+1}, the entrance angle ϕ_{a+1} for curve Z_{a+1}, Z_{a+2} would be forced equal to the interknot angle B_{a+1} at Z_{a+1}.

Code 9 denotes Linear Interpolation - Smooth Knot and may be used, for example, to force a smooth knot located at the end of a curve Z_a, Z_{a+1} which then becomes a straight line, or at the end of a straight line, which then becomes a smooth continuous curve.

The use of override control code 9 is shown in FIG. 6a where a knot joins a straight line curve Z_a, Z_{a+1} to a smooth continuous curve, Z_{a+1}, Z_{a+2}. In this case, θ_{a+1} is set equal to B_a.

Where a knot joins a curve section Z_a, Z_{a+1} to a straight line curve, Z_{a+1}, Z_{a+2}, as shown in FIG. 6b, then ϕ_a, the exit angle for curve Z_a, Z_{a+1} is made equal to B_{a+1}, the interknot angle between Z_{a+1}, Z_{a+2}.

It should be understood, however, that if a knot joins two straight lines, this rule shown with respect to FIG. 5 is used in the preferred embodiment.

Control code 10 directs a curve interpolation at a sharp knot and is used to form a cusp at the entrance knot or the exit knot of a smooth continuous curve segment joined by that knot to a straight line. Shown in FIG. 7a, are two examples, i.e. the curve Z_a, Z_{a+1} is formed with a sharp knot at the entrance knot Z_a and the curve Z_{a+1}, Z_{a+2} is formed with a sharp knot at the exit knot Z_{a+2}. This control code is useful in overriding a default command code which would otherwise require that the sharp knot at Z_a, for example have an entrance angle for curve Z_a, Z_{a+1} equal to B_a which would introduce a distortion in curve Z_a, Z_{a+1} at area 31, approximate the entrance knot Z_a for curve Z_a, Z_{a+1}, as shown in FIG. 7b. Similarly, a distortion would be introduced in a smooth continuous curve terminating in a sharp knot. For example, in curve Z_{a+1}, Z_{a+2} as shown by numeral 33 in FIG. 7b, approximate the exit knot Z_{a+2}, where ϕ_{a+1} would be forced to equal B_{a+1} to form a cusp. code 10 overrides the default command code and forces θ (i.e. θ_a) to be equal to Φ (i.e. Φ_a).

Where a cusp is to be formed at knot Z_a, the default command code would specify that the exit angle, ϕ_a at knot Z_a would be equal to the interknot angle B_{a-1} at the preceding knot Z_{a-1}, for curve Z_{a-1}, Z_a, and the entrance angle λ_a for curve Z_a, Z_{a+1} would be equal to the interknot angle B_a between the entrance knot Z_a for curve Z_a, Z_{a+1} and its exit knot Z_{a+1}. As stated above, this would produce the result shown in FIG. 7b, and a distortion of the smooth continuous curve Z_a, Z_{a+1} shown in FIG. 7a. With the result of FIG. 7b, the deviance angle θ_a between B_a and λ_a would be zero as stated above. In this case, to avoid the distortion shown by numerals 31, 33 in FIG. 7b and to produce the smooth continuous curve as shown in FIG. 7a, θ_a is forced equal to Φ_a the deviance angle, at exit knot Z_{a+1}, as stated above. In the case shown in FIG. 7a, arranged, for the sake of explanation ϕ_a is equal to zero, Φ_a is equal to B_a.

A similar result is forced by using a code 10 to control the shape of curve Z_{a+1}, Z_{a+2} at exit knot Z_{a+2}. As stated above, the default command code responsive to a cusp at Z_{a+2} for example, would direct the curve Z_{a+1}, Z_{a+2}, to the shape shown in FIG. 7b and particularly shown by numeral 33 approximate Z_{a+2} by directing that the exit angle ϕ_{a+1} at knot Z_{a+2} is equal to the interknot angle B_{a+1} at the entrance knot Z_{a+1} for that same curve. However, by using code 11 to direct that Φ_{a+1} is equal to θ_{a+1}, then at exit knot Z_{a+2} for curve Z_{a+1}, Z_{a+2} ϕ_{a+1} is equal to $2*B_{a+1}$ ($\phi_a=0$, $\lambda_{a+1}=0$, $\theta_{a+1}=\lambda_{a+1}-B_{a-1}$).

For the sake of explanation, δ_{a+1} is equal to Ø, for curve Z_{a+1}, Z_{a+2}.

The effect of code 1Ø is to produce a smooth continuous curve from or to a cusp such as at entrance knot Z_a or at exit knot Z_{a+2} and symmetrical about the respective curve midpoints, as shown by numeral 35 and numeral 37, respectively for curve Z_a, Z_{a+1} and for curve Z_{a+1}, Z_{a+2}.

Control code 1Ø is to override a default command code which would otherwise specify a cusp, such as where the exterior angle as described above was above a threshold such as 4Ø° as shown in the preferred embodiment, or the interknot distance was greater than a predetermined distance, such as 12Ø units in the preferred embodiment. In this case, a smooth knot would be formed as described above, by taking the average of the interknot angles between a preceding knot and the subject knot and the subject knot and a successive knot in the outline loop direction of the closed outline loop. However, as explained above, if the absolute value of the interknot angles between the preceding knot and the subject knot and the subject knot and the successive knot is greater than 18Ø°, then the supplemental average is used by supplementing the average angle by 18Ø°. This is to orient the angle in the correct direction where the relationship of the average angle described above would result in a resultant angle 18Ø° out of phase with its correct direction.

The application of the inventive principles will force the angular relationships of δ ψ, θ and Φ at the respective knots to conform to the rules described above, as necessary to produce the desired curve, straight line, cusp, or smooth knot, whether directed by the default command codes or by the override control codes. It should be noted, however, that where an override control code is used, it is used to force a result contrary to what would ordinarily be produced using the default command codes. For example, if the default command code would produce a cusp and a smooth knot was desired followed by a smooth continuous curve or preceded by a smooth continuous curve, then a code 10 would be used. If the default command code would have produced a smooth continuous curve, and a straight line joining a sharp knot is desired, then a code 8 would be selected. If a smooth knot is desired joined to a straight line, then a code 9 may be selected to override the default command control. All of the foregoing is shown in connection with FIGS. 5, 6, 6a, 7, 7a and 8 and in the text accompanying these figures.

A typical encoding for an A as shown in FIG. 9 is shown in the appendix. The compiler for decoding the packed encoded information is also shown below, and is used with a Motorola 68000 processor. As the desired output is a series of intercepts at the intersection of the locus of the character outline, and the display raster lines, these intercepts can be converted into modulating information for imaging the character on an imaging surface by any suitable well-known imaging device.

For the sake of explanation and in the way of an example, a closed data loop for the encoded A shown in FIG. 9, is set forth below and described.

CLOSED DATA LOOP FOR THE "A" OF FIG. 9

(Given in hexadecimal Notation)

```
83 98 3C 82 E8 5E 02 4C 01 5C 02 5E 16 49 00 5B
30 B2 54 D6 75 96 83 78 81 A7 D7 5A 37 1B 80 7C
```

57 3A 83 89 ØE 85 EØ 28 24 15 CØ 2Ø 49 77 96 88
7D 2F 3Ø 6Ø 62 F1 6D ØF 6Ø 26 AD 28 2Ø C1 8A 88
Ø6 5Ø 1Ø Ø6 95 99 7B 88 58 8Ø BØ 82 Ø8 Ø1 3A 7Ø
FF FF ØØ 1Ø 79 Ø6 5Ø 37 31 19 7B 73 53 81 51 79

As stated above, the closed data loop is encoded on data words of 4 bit or nibble boundries and the sequence of the nibbles is as given below. In accordance with the preferred embodiment, the first two bytes 5B of the closed data loop indicate the total number of bytes in the data loop for a closed outline loop. The first two bytes, ØØ 5b indicates that there are 91 bytes total in the data loop for the symbol A, describing outside closed outline loop 31 in the direction of arrows 31 and inside closed outline loop 35 in the direction of arrows 35.

In accordance with the preferred embodiment, the starting X and Y coordinates are given in three nibble packs of information for each respective X and Y location. Accordingly, the next three nibbles, 6 49 relates to the starting X location. In accordance with the principles of the invention and the preferred embodiment, the least significant bit of the data for a new X or a new Y location is a sign bit indicative of the direction. Accordingly, in processing the data in the preferred embodiment, a shift of one binary position is made to remove the sign bit, giving a decimal data value of 8Ø4. As described above in the preferred embodiment, since the origin of the M^2 is offset by 592 units, 592 must be subtracted from 8Ø4 to provide the correct X coordinate with reference to the origin of the M^2 of 212. The sign of the X direction, whether positive or negative with regard to the origin of the M^2 is given by the sign bit and is positive if the sign bit is zero, in the preferred embodiment.

In accordance with the principles of the invention, the starting Y position given as a new Y position is indicated by the next nibble series of 3 nibbles or by 5E1, which is divided by 2 to remove the sign bit yielding the result of 75Ø. In accordance with the offset of the M^2 at 736 units, 736 is subtracted from 752 to yield a Y coordinate of 16. The sign bit which is a 1, indicates a negative direction for Y. Accordingly for the "A" of FIG. 9, the start point x, y coordinates shown as numeral 39, is 212, 16 with the new direction being x,-y.

As stated in the preferred embodiment, the data pack is decoded by using the first two bytes to indicate the number of bytes in the closed data loop corresponding to the coordinate points around the closed outline loop, and by three nibbles each comprising twelve bits corresponding to the respective X and Y start locations. It should be noted that wherever the X coordinates are defined by new coordinate values, the least significant bit is used as a sign bit to indicate the coordinate direction. The process performs a divide by two which separates that bit to define the aforesaid direction signed. Additionally, the X position is referenced to the home or reference position in the M^2 which may be offset with regard to the origin of the master encoding grid by subtracting the offset from a coordinate position accordingly. With this in mind, the following process is described which produces the listing of coordinates shown below and in FIG. 9.

As stated, the start position is at XY coordinates 212, Ø. As the last bit of data accessed from the data pack, to provide complete information for the preceding nibble series was the tenth nibble corresponding to hexadecimal number 5. The next nibble which follows a complete information series of nibbles is a first nibble value.

As shown, the first nibble value 2 indicates a case Ia and according to table II directs the access of the next three nibbles, 5C0 indicative of the new X coordinate position. In accordance with the procedure above, a division by 2 removes the sign bit and a subtraction process is performed relative to the M^2 offset, to reference the new Y position to the M^2 home position or at zero. The first nibble value "1", following the nibble series for the completed information set of 5C02 then indicates a case Ia and a new X coordinate. In accordance with the process described above, a binary division of two is performed to isolate the sign bit, indicate the direction and a subtraction is performed to reference the new X position to the home position. Accordingly, the new X position is 16.

The next coordinate position of 16,16 is given by the complete information set 2E8, with the nibble series first nibble value 8 indicating of a Case III. In accordance with the format of the data pack as shown in Table I, P = X is equal to 01110 and Q = y is equal to 00010. This translates to 14 and 2 in decimal rotation respectively. In accordance with the preferred embodiment, as it would be redundant to use Cases II, III and IV, for a translation of 0, a 1 is added to the results of p = x and q = y to provide the new X and Y coordinate distances of 15 and 3 respectively. The p value is added to previous X value of 16 to provide a new X value of 31, and the q value is added to the previous Y value of 16 to provide a new Y value of 19 accordingly.

As a reminder, it should be understood, that this process of decoding the data pack being described is designed to decode the encoded knot coordinates only. After decoding the inventive principles described herein are applied to the knots to either produce a series of nodes describing a smooth continuous curve between the knots, as between knots 16, 16, and knots 31, 19 or a straight line as between knot 212, Ø and knot 16, Ø. In accordance with the preferred embodiment, the direction of the knots indicated by the completed information set 2E8 relative to the previous knot is in accordance with the direction established by the last previous sign bit accessed for the respective X and Y directions as shown above, or by 567 as described below.

The next nibble following the nibble series for the completed information set above has the first nibble value of 8 which is a Case III, directing the access of the next two nibbles for providing the nibble series for complete information set of 3C8 corresponding to a p = x value of 13 and a q = y value of 4 in accordance with the format shown in Table II. In accordance with the preferred embodiment, the direction of the knot denoted by this complete information set follows the last previous direction indication given and is accordingly added to the previous coordinates of 31 and 19 to provide new coordinates of 44 and 23.

In accordance with the foregoing, the next nibble being a first nibble value is 8 which accordingly directs the access of the next two nibbles to provide a complete information set of 398 producing new coordinate values of 54, 27, accordingly.

The next nibble corresponding to a first nibble value of 8, as described above, indicates a case 8 and directs the access of the next two nibbles to form the nibble series corresponding to the complete information set of hexadecimal 7C8 and according to the processing described above decoding the new coordinates of 67, 35.

As can be seen, the smooth continuous curve between knot end points 16,16 and passing through knots 31, 19 and 44, 23 and 54, 27 and, 67, 35 are formed according to the principles of the invention to form a smooth continuous curve.

The next first nibble value of the next complete information set is zero indicating Case Ib which directs the access of another nibble to form a two nibble series complete information set. As the next nibble was 8, for Case Ib, a value of 3 is added thereto forming a value of 11, indicative of control code 11 directing a smooth continuous curve be formed between the last knot having coordinate 67, 35 and the next knot which is to be indicated by the next complete information set accessed from the closed data loop.

As the first nibble value of the next complete information set is B indicating Case III, 3 nibbles are accessed forming a 4 nibble series describing the next complete information set and producing the new coordinates of 85, 59.

The next first nibble value of the next nibble series for the next complete information set is 3 indicating Case Ia, control code 3, shown in Table II, and which directs the access of a pair of three nibbles each which are indicative of the next X and Y positions and directions thereof relative to the previous knot. In accordance with the process described above, the new X and Y position is 349, 6Ø6 and as the distance between this new knot and the previous knot is greater than 128 units, the default command code directs linear interpolation. In

accordance with the above, the hexadecimal value 75A corresponds to the new X position and A7D corresponds to the new Y position. As stated above, the least significant bit of each of the above 3 nibbles corresponds to the relative direction of the new X and Y points.

The first nibble value of the next nibble series for the next complete information set is 1 indicating a Case Ia and directing the access of the next three nibbles of 7A8 to replace the X coordinate with 372 and a new set of coordinates 372, 6Ø6.

The next first nibble value for the next nibble series is a 3 corresponding to a case Ia, a control code 3 and the access of a pair of 3 nibbles, i.e. 968, corresponding to the new X position and 675, corresponding to the new Y positions and new X, Y coordinates of 612, 9Ø respectively.

The next first nibble value following the nibble series for the complete information set above is D, corresponding to Case IV which directs the access of the next three nibbles to form the 4 nibble series 254, and which according to the form shown in Table I provides a p = x value of 2Ø and a q = y value of 37. According to the process described above, a 1 is added to the p = x value and the q = y value to form decimal coordinate values of 21 and 38. Following the most recent X, Y coordinate direction instructions given, the X incremental value is added to the previous coordinate 612 providing the new X coordinate of 633 and the Y incremental value is subtracted from the previous Y of 90 to provide a new Y coordinate value of 52.

The next first nibble value of the next nibble series for the next complete information set is a B corresponding to Case III which directs the access of two more nibbles to form a three nibble series, complete information set, and producing the next coordinate values of 650, 32 for X and Y respectively.

The next first nibble of the next nibble series for the next complete information set is 8 corresponding to a Case III, causing the access of the next two nibbles to produce a three nibble information set and new coordinate values of 659, 25 for X and Y respectively.

The next first nibble value is a 9 corresponding to case III and directing the access of the next two nibbles of 77 and corresponding to new X and Y coordinate 683, 17.

The next first nibble value is a 9 causing the access of the next two nibbles 04 and corresponding to the new X, Y coordinates with 704, 16.

The next new first value is 2 corresponding to Case Ia and directing the access of the next three nibbles corresponding to the 5C0 corresponding to a new Y value with the direction indicated by the first significant bit therein and producing new XY coordinates of 704, 0 respectively.

The next first nibble value of the next nibble series for the next complete information set is 1 corresponding to a Case Ia and directing the access of the next two nibbles forming a three nibble series complete information set 824 and corresponding to the new X, Y location of 450, with respect to the last previous direction given for the axial directions X and Y.

The next first nibble value 4, the next complete information set is 2 corresponding to case Ia and to complete information sets 5E0 corresponding to new XY coordinates 450, 16.

The next first nibble value is 8 corresponding to Case III and as described above corresponding to complete information set 0E8 and new XY coordinates 465, 17.

The next first nibble value is 9 corresponding to Case III and complete information set 389 and new XY coordinates 490,21.

The next first nibble value is 8 corresponding to Case III and complete information set 38A and new XY coordinates 501,25.

The next first nibble value is 7 corresponding to Case II which directs the access of another nibble and according to the format shown in Table II provides a p = x value of binary 101 corresponding to a decimal value of 5 to which one is added in accordance with the procedure above to provide a decimal value of 6 for the new X coordinate incremental distance. Similarly, the q = y value is binary 011 which corresponds to a decimal value of 3, to which one is added in accordance with the process above to provide a new value of 4 corresponding to the incremental Y coordinate distance. The new XY coordinates are therefore 507,29 accordingly to the directions given in the last previous direction instruction.

The next first nibble value is 8 corresponding to Case III and the access of two more nibbles to form the complete information set A88 and XY coordinates 516, 40.

The next first nibble value is 8 corresponding to Case III, the access of the next two nibbles form a complete information set C18 and new coordinates XY of 518, 53.

The next first nibble value is zero corresponding to case Ib which directs the access of the next nibble to, which 3 is added in accordance with procedures described above to form the control code 5. As shown in Table II is an X Negate which changes the X direction from its previous direction. The next first nibble value is an 8 corresponding to Case III and in accordance with the foregoing new X, Y coordinates 515, 67.

The next first nibble value is 8 corresponding to case III and new coordinates of X, Y of 508, 86, respectively in accordance with the above procedure.

The next first nibble value is a 0 corresponding to case Ib which directs the access of the next nibble 6 to which 3 is added according to the above procedure to provide a control code of 9. 9 as shown in Table II is a line smooth direction.

The next first nibble value is F corresponding to Case IV and in accordance with the procedure above causes the access of three more nibbles forming the complete information set 600F and new X, Y coordinates 459, 196 in accordance with directions as given.

The next first nibble value is 1 corresponding to Case Ia which directs the access of the next three nibbles, 62F indicative of an X coordinate point in accordance with the last previous directions given. Accordingly, the new X, Y coordinates are 199, 196.

The next first nibble value is zero corresponding to Case Ib and directs in the access of the next nibble having a value of 6 to which 3 is added in accordance with the above procedure to produce a 9 corresponding to control code 9. A next first nibble value is zero once again corresponding to Case Ib which directs the access of a next nibble which is 3 to which 3 is added giving the control code value 6 which means negate Y.

The next first nibble value is F corresponding to Case IV and in accordance with the above procedure causes the access of the next three nibbles to complete the information set 7D2F and producing new X, Y coordinates of 148, 70 which is connected to the previous X, Y coordinates 199, 66, according to the override control code 9 and in the new Y direction.

The new first nibble value is zero corresponding to case Ib and directing the access of the next nibble having a value of 7 to which 3 is added to give it the control code 10.

The next first nibble value is an A corresponding to Case III and directing the access of the next two nibbles to give the complete information set 13A and new X and Y coordinates 144, 52 respectively.

The next first nibble value is zero corresponding to Case Ib which directs the access of another nibble having a value 8 to which 3 is added in accordance with the above procedure to provide the control code 11.

The next first nibble value is zero corresponding to Case Ib directing the access of another nibble having the value 2 to which 3 is added giving the control code 5 which negates the previous X direction.

The next first nibble value is A corresponding to Case III and the access of two additional nibbles giving the complete information set B08 and new XY coordinates 145, 40.

The next first nibble value is zero corresponding to case Ib in accordance with the above procedure control code 11.

The next first nibble value is 8 corresponding to Case III, complete information set 858 and new XY coordinates 151, 31.

The next first nibble value is 8 corresponding to Case III, complete information set 7B8 and new XY coordinates 163,23.

The next first nibble value is 9 corresponding to Case III, complete information set 599 and new XY coordinates 189,17. The next first nibble value is 9 corresponding to complete information set Ø69 and coordinates 212, 16.

The above XY coordinates 212,16 bring the traverse of the closed data loop bringing it back to the starting point.

The next first nibble value is zero indicating Case Ib with the next access nibble I to which 3 is added producing the control code value 4 indicating the end of closed data loop.

In accordance with the preferred embodiment, a routine is added, not shown, which would be known to one skilled in the art to ensure that the closed data loop decoding closes upon the start location of the closed data loop and completes the closed outline loop by ending at the start point encoding of the closed data loop which represents the start of the closed outline loop.

The second closed outline loop, shown by numeral 35 and arrows 37, of the A now starts at the closed data loop coded hexadecimal numbers 79Ø, 65Ø corresponding to new X and Y coordinate values 216, 232 and the X and Y directions, derived according to the process given above with the regard to the start points for the foregoing loop, 31.

The next first nibble value is 1 corresponding to Case Ia and directing the access of the next three nibbles 815 and new XY coordinates 442, 232.

The next first nibble value is a 3 corresponding to a Case Ia, directing the access of a pair of three nibbles 735, and 97B corresponding to new X and Y coordinates of 33Ø and 477 in the negative X and negative Y directions accordingly.

The next first nibble value is 1 corresponding to Case Ia directing the access of the next three nibbles 731 corresponding to X coordinate 328, Y coordinate 477 in the negative X and negative Y directions accordingly.

The next first nibble value is 3 corresponding to Case Ia directing the access of a pair of three nibbles each corresponding to hexadecimal value 690 and 790 and X and Y positions 216, 232, respectively. As 216, 232 are the start points, the closed data loop representing the closed outline loop 35 has been completed and the next first nibble value is zero indicating Case Ib with the last nibble accessed accordingly being zero indicating the end of loop. Once again, the routine described above is used to insure that the closed data loop ends at its start point.

The above is a representative encoding of a letter used in the process to derive the coordinate values around the outline of the character and any override control codes which may be used to replace default command codes. However, it should be understood that changes to the codings could be used consistent with the principles of this invention, as claimed herein, and that the invention should not be restricted to the coding or decoding process shown above, with respect to the preferred embodiment.

AUTOSCALING LINEAR INTERPOLATION

Linear interpolation is a well-known technique and is not claimed as an invention in this application. The autoscaling linear interpolation which is claimed and which is described below is a method of increasing the precision of a machine interpolation procedure which uses as a start point, a first set of coordinates and as an ending point a second set of coordinates. The coordinates are usually expressed in respective coordinate directions such as x and y, for example. In the preferred embodiment, the process of linear interpolation is for the purpose of producing coordinate points along a straight line between the first and second end points, which coincide with a second coordinate system such as the intercepts in a raster display. Each of the coordinates are found by determining the slope of the straight line between the two end points which is equal to the incremental distance in a first coordinate direction divided by the incremental distance in a second coordinate direction (i.e. Y_2-Y_1/X_2-X_1). That first coordinate incremental distance is expressed in an encoded machine value as a first data word, (i.e. Y_2-Y_1), in a first machine location. The second coordinate incremental distance between the two end points in the second coordinate direction (i.e. X_2-X_1), is also expressed as a machine value and placed in a second machine location. The machine location limits the precision by which a data word may be expressed. For example, and as is well-known, each machine is based upon radix, which is a number base. The most common machine number base is the binary number base. Each data word accordingly, has a number of bit positions with each specified bit position being a specified power of that radix (i.e. 2^4, 2^3, 2^2, 2^1, 2^0, 2^{-1}, 2^{-2},). Accordingly, a shift of a data word in a direction of the most significant bits corresponding to higher exponential values or higher orders of the machine radix, results in an increase in the scale or value of the data word. Further, each shift in the direction of the most significant bits, results in an effective multiplication of the data word value by a scale factor of the machine radix raised to an exponential power corresponding to the number of bits shifted (i.e. 13 bit positions shifted is equal to a scale factor of 2^{13} in a binary machine or equivalent of 8196, in decimal notation. Conversely, each shift of a data word, towards the least significant bits, corresponding to lower exponential values or orders of that machine radix, corresponds to an effective division by the machine radix value and conversely to a reducing scale factor. Further, machine locations for storing data words are limited in the number of bits available. As the precision of a data word is a function of the data space and the number of bits available for storing that data word, an increased precision for expressing a data word are obtainable by extending the number of bits or size of a machine location available for specifying a data word. For example, as is well-recognized, in a decimal system, the number 5.632498 is a more precise value than 5.3624 which lacks the last three significant places (i.e. .000098), of the former number. In binary, the number 10111.101 is a more precise expression than that number truncated or rounded to 10111.000, as the latter number is missing the bits .101 and is therefore less precise. However, the former binary expression requires a larger machine location for specifying all the relevant bits in that expression. The "point" in the above binary and decimal values are used to indicate the positions, according to the radix system used, to indicate position values equal to or greater than 1 (decimal) and less than 1 (decimal)(i.e. integer and fractional values).

The effect of shifting to increase the scale of the Y increment is to eliminate the binary point in a third data word representing the slope or Y incremental value and thereby avoiding floating point arithmetic operations. The point separates the bit positions in the radix system selected, separating fractional from integer values in a data word having values equal to or greater than 1 and less than 1 (i. e. between the bit positions "2^0" and "2^{-1}". The binary point is equivalent to the decimal point in a radix 10 system and equivalent to a "point" between those machine positions having a value equal to or greater then 1 and less then 1 in any system and as stated, separating the fractional values from the integer values in the slope or Y increment value. By shifting a machine representation of a number in the direction of more significant bits, the scale of the number is increased, thereby moving the "point" effectively in the direction of the less significant bits. If a sufficient number of bit positions are shifted, the binary point is eliminated from the number. In this way, floating point arithmetic is avoided.

According to the invention, linear interpolation proceeds according to the known method by determining the coordinate distance in a first coordinate direction and in a second coordinate direction between a set of end points. The method is used in the machine having a radix "r" cooresponding to the values of designated bit positions in the encoded words used within the machine. The process continues by encoding a first data word on "N" bits corresponding to the distance between the first and second end points in the first coordinate (i.e. Y_2-Y_1), and then placing that first data word in a first machine location. To complete the process of calculation the slope, according to the interpolation method, a second data word of M bits corresponding to the distance between the first and second end points (i.e. X_2-X_1) in a second coorindate direction is encoded and placed in a second location. The machine is now ready to use the data value in the first location and a data word value in the second location in a process of division to produce a third data word corresponding to the slope of the straight line between the first and second end points (i.e. Y_2-Y_1/X_2-X_1). To increase the precision or resolution of the third data word according to the inventive process, the scale of the first data word (i.e. Y_2-Y_1), is increased by determining the the number of available positions between the most significant position of the first data word and the most significant position of the first machine location. The first data word is then shifted in a first direction towards the most significant positions in that first machine location, utilizing those more significant positions which were unused, when expressing the first data word. The scale of the first data word is again increased by shifting a second time in the same first direction of the most significant positions by a number of positions cooresponding to the number of bit positions used to encode the second data word (i.e. X_2-X_1). In the preferred embodiment, the first machine location is expanded to accommodate this additional shift. It should be noted that the inventive principle is not limited to the size of available data space in any one machine or to any machine radix.

In the preferred embodiment, the second shifting operation described above occurs in an extension to the first machine location. The quotient corresponding to the slope (i.e. Y_2-Y_1/X_2-X_1) produced as the third data word by division of the first data word by the second data word will reduce the first data word to a size coextensive with the first machine location. As a result then, the data word may be raised by a scale factor corresponding to a shift in the direction of the most significant positions corresponding to the number of significant positions used to express the denominator (i.e. X_2-X_1) or second data word, as the next division step cancels that said shift of the first data value by the said number of bit positions in the second data word and cooresponding reduces its position length to the size of the first machine location.

The third encoded data word (i.e. the Y incremental value for each X increment) is then stored and added to the first data word (i.e. Y_1). The second data word (i.e. X_1) is incremented a coordinate word value corresponding to the first and second coordinate positions of a point along the line are then stored. In Table III are given the coordinate X, Y values; the value of Y incremented at its highest precision and scale factor for the example shown.

In the iterative process, the third encoded data word at the higher resolution, produced, corresponding to the slope produced according to the above, is used iteratively as a Y incremental value to derive a cumulative Y incremental value related to a respective X coordinate value in the first direction (i.e. Y) and stored as a cumulative Y. As no change has been made to the precision (i.e. the number of positions used to express the third data word), the precision of the third data word is the same as the first data word, produced by shifting the first data word and increasing its scale, as described.

As interpolation is an iterative process, the data word (i.e. the Y incremental value at the said higher precision), is used to produce the cumulative Y, related to the Y coordinate for a respective X coordinate.

As the purpose of producing data word values corresponding to points along a straight line, is to produce intercepts on a display coordinate system, the scale cumulative Y words are reduced to the scale used to express the end point coordinate values, by the step of truncating or rounding. Truncating may be accomplished by discarding a predetermined number of least significant bits or rounding may be used by a shift in the direction of the least significant bits, minus one, adding a bit corresponding to the rounding value such as .5 (decimal) and discarding any bits having values less than the least significant bit value of interest. In the preferred embodiment, truncating or rounding is to the position of the lowest integer value in the radix 2 system (i.e. to bit position 2^0).

In the foregoing manner, the scale of cumulative Y is then reduced to fit scale of the data words for the end point coordinates. In the preferred embodiment, the original precision is that of the coordinates on a display which are the display intercepts, shown as X, Y in Table III. The result of using this method is to avoid the incremental error introduced into each cumulative Y value by summing Y incremental at a lower scale.

The incremental value at the increased scale factor may be used to derive a cumulative Y for each respective coordinate X values by iteratively incrementing Y increment by Y increment to produce a first cumulative Y and then incrementing that first cumulative Y with the Y incremental value and so on to produce a series of distinct cumulative Y values at the higher scale factor for each X coordinate. The discrete cumulate Y values may then be reduced by the scale factor to the scale of the numerator (dx) before shifting and added to the initial Y coordinate value to produce the correct Y coordinate for each respective X coordinate. By producing the cumulative Y using Y increment at the increased scale factor, cumulative errors in the Y coordinate value due to an error in the cumulative Y value due to the lower scale factor of Y increments are avoided.

An example is shown in Table III. In the preferred embodiment, a radix 2 machine is used with locations of 16 bits each used and with the most significant or 16th bit being used for a sign bit. The Y register, therefore, corresponding to a first data word of 120 would be 0000 0000 0111 1000. As the leftmost or most significant bit of the register is not available for indicating the numerical value, as it is a sign bit in the preferred embodiment, then the first data word expressed in binary, may be shifted to the left in the direction of the most significant bits, a total of eight places corresponding to the eight zeros or unused binary bit positions to the left of "111 1000." The updated first data word, as shown in the register is now 0111100000000000 corresponding to a decimal value of 30,720.

The denominator corresponding to the distance between the end points in a second coordinate direction and to the second data word is the binary word 0000 0000 0011 0010 equal to a decimal value of 50. The quotient produced by the division of the dividend or first data word by the denominator or second data word produces a quotient having a number of bits related to the number of bits in the dividend reduced by the number of bits in the divisor or denominator. In the divisor, the most significant bit is in the 6th bit position corresponding to a decimal 2^5 or decimal of 32. The numerator corresponding to the first data word and expressed as the 16 bit binary word 0111 1000 0000 0000 may be raised by an order of the radix, (i.e. 2^5) corresponding to the order of the most significant bit position of the denominator, with the assurance that the quotient will fit within the register size containing the first data word after shifting above and without loss of any significant bits in the quotient, such as, for example, bit corresponding to the remainder.

To summarize the foregoing, the precision of data word for the numerator value, used in deriving the slope can be raised within the space allotted by a machine register by shifting the significant bits of that data word to the left or towards the most significant bit in the register equal to the number of unused bits in the register or in the example between the most significant bit position for the first data word shown, or seventh bit position and the most significant bit position available in the register. This causes the binary word corresponding to the numerator to be stated at its highest value thereby avoiding floating point arithmetic. The precision of the slope used in linear interpolation may be further increased by expanding the register space available for storing that binary word and shifting hat first data word to the left, effectively raising it by a power of the radix used, corresponding to the number of significant bits in the denominator or divisor. As stated above, as the slope is the quotient produced by the division of the dividend or numerator (first data value), by the divisor or denominator (second data value), a shift of the numerator by the number of significant bits in the denominator, after division produces a quotient having a number of significant bits no greater than the dividend. In this way, the precision of the quotient or incremental value in the first coordinate direction is maintained equal to the precision of a numerator.

To continue with the example above, as the divisor contains 6 significant bits corresponding in binary notation to it 2^5 or 32 then the numerator may be shifted to the left for a total of 13 places by increasing the scale, raising the value of the first data word by a scale factor of 2^{13}. As 2^{13} equals decimal 8192, the arithmetic accomplished in binary form and expressed in decimal is

$$\text{dec. } \frac{120 \times 8192}{50} = \frac{\text{F0000}}{32} \text{ HEX where } 120 = Y_2-Y_1; \quad 50 = X_2-X_1;$$

The first coordinate or Y incremental value is expressed in decimal as 19660/8192 = 2.399902 or 4CCC in HEX. The actual incremental value defined by the coordinate end points is 120/50 = 2.4. The difference between the Y incremental value, expressed as a third data word and the actual slope is 4×10^{-3}% error. As shown in Table III, the Y incremental produced at the higher precision is used to iteratively increment Y, which is then reduced in scale accordingly and added to the first end point in the first coordinate direction (Y direction) and that Y coordinate value is stored. In reducing the scale, the Y value may be truncated or rounded, to produce an intercept value, for example. As shown in Table III below, the intercept value is shown as produced by truncation and rounding.

Additionally, to increase the speed of the process, the value of the first data word or numerator may be compared to successive entries in an ordered set of values. By a comparison of the value of the first data word it can quickly be determined whether the coordinate difference (i.e. Y_2-Y_1) is greater or lesser than a value in a particular position of the set of values. Accordingly, the set of values may be arranged in decreasing orders of the machine radix, (i.e. 2^{13}, 2^{12}, . . . 2^{0}). By a successive process of comparison in the decreasing order, it can easily be determined where in this procedure, the first data word in the first machine location is less than a value in the set of values. Then that particular value in the set of values could be referenced to an index value to indicate the number of bits available in the numerator register for shifting the first data word. It should be noted that according to the principles of the invention, it is not necessary where the denominator is a power of two, such as two or four, to divide, saving additional time, as shifting of the numerator accomplishes the same result.

Accordingly, the above process is equally valid for the reverse process where the set of values is in increasing order and the comparison is in the increasing order with the particular value of interest in the set being the first greater than the first data word.

In this way, it is possible to avoid floating point arithmetic by increasing the value of the numerator and corresponding to the number of unused bits available in the register for shifting while further increasing the value of the numerator corresponding to the number of significant bits in the denominator to maintain the power of two of the most significant bit of the quotient equal to the power of two of the most significant bit of the dividend and thereby increasing the precision of the quotient and the answer. Additionally, it is possible to use a set of values such as a look up table for example, to compare the value of the numerator to values in the denominator, selecting as an index number related to a value in said set of values to indicating the number of positions available for shifting the numerator by arranging the set of values in an order of values corresponding to decreasing or increasing orders of the radix and successively comparing the numerator value in the order of said decreasing or increasing powers of the radix until a particular value is found which is greater or less, respectively than the numerator value. That particular value can then correspond to an index value corresponding to the power of two available in the register for shifting the numerator and increasing its value by a power of two.

As would be apparent to those skilled in the art, the inventive principles can be applied to any radix system or to any coordinate system.

TABLE III

Start Point	Delta_X=50		
X_1, Y_1 = 0, 0	Delta_Y=120	Y incremental = 19660 dec.;	
End Point			4CCC Hex
X_2, Y_2 = 50, 120		Scale Factor = 105134 dec.	

(truncated) X,Y	(rounded) Y	Cumulative incremental Y per X coordinate		
1,2	[2]	Sum=	19660 =	4CCChex
2,4	[5]	Sum=	39320 =	9998hex
3,7	[7]	Sum=	58980 =	E664hex
4,9	[10]	Sum=	78640 =	13330hex
5,11	[12]	Sum=	98300 =	17FFChex
6,14	[14]	Sum=	117960 =	1CCC8hex
7,16	[17]	Sum=	137620 =	21994hex
8,19	[19]	Sum=	157280 =	26660hex
9,21	[22]	Sum=	176940 =	2B32Chex
10,23	[24]	Sum=	196600 =	2FFF8hex
11,26	[26]	Sum=	216260 =	34CC4hex
12,28	[29]	Sum=	235920 =	39990hex
13,31	[31]	Sum=	255580 =	3E65Chex
14,33	[34]	Sum=	275240 =	43328hex
15,35	[36]	Sum=	294900 =	47FF4hex
16,38	[38]	Sum=	314560 =	4CCC0hex
17,40	[41]	Sum=	334220 =	5198Chex
18,43	[43]	Sum=	353880 =	56658hex
19,45	[46]	Sum=	373540 =	5B324hex
20,47	[48]	Sum=	393200 =	5FFF0hex
21,50	[50]	Sum=	412860 =	64CBChex
22,52	[53]	Sum=	432520 =	69988hex
23,55	[55]	Sum=	452180 =	6E654hex
24,57	[58]	Sum=	471840 =	73320hex
25,59	[60]	Sum=	491500 =	77FEChex

26,62	[62]	Sum=	511160	=	7CCB8hex
27,64	[65]	Sum=	530820	=	81984hex
28,67	[67]	Sum=	550480	=	86650hex
29,69	[70]	Sum=	570140	=	8B31Chex
30,71	[72]	Sum=	589800	=	8FFE8hex
31,74	[74]	Sum=	609460	=	94CB4hex
32,76	[77]	Sum=	629120	=	99980hex
33,79	[79]	Sum=	648780	=	9E64Chex
34,81	[82]	Sum=	668440	=	A3318hex
35,83	[84]	Sum=	688100	=	A7FE4hex
36,86	[86]	Sum=	707760	=	ACCB0hex
37,88	[89]	Sum=	727420	=	B197Chex
38,91	[91]	Sum=	747080	=	B6648hex
39,93	[94]	Sum=	766740	=	BB314hex
40,95	[96]	Sum=	786400	=	BFFE0hex
41,98	[98]	Sum=	806060	=	C4CAChex
42,100	[101]	Sum=	825720	=	C9978hex
43,103	[103]	Sum=	845380	=	CE644hex
44,105	[106]	Sum=	865040	=	D3310hex
45,107	[108]	Sum=	884700	=	D7FDChex
46,110	[110]	Sum=	904360	=	DCCA8hex
47,112	[113]	Sum=	924020	=	E1974hex
48,115	[115]	Sum=	943680	=	E6640hex
49,117	[118]	Sum=	963340	=	EB30Chex
50,120	[120]	Sum=	983000	=	EFFD8hex

The effect of shifting to increase the scale of the Y increment is to eliminate the binary point in a third data word representing the slope and Y increment and thereby avoiding floating point arithmetic operations. The binary point separates the bit locations separating fractional from integer values in a data word (i.e. having values equal to or greater than 1 and less than 1 (i.e. between the bit positions "2^0" and "2^{-1}". The binary point is equivalent to the decimal point in a radix 10 system and equivalent to a "point" between those machine positions having a value equal to or greater than 1 and less than one in any system and separating the fractional values from the integer values in the slope or Y increment value.

By shifting in the direction of more significant bits, the scale factor of Y increment is increased, thereby moving the "point" effectively in the direction of the less significant bits. If a sufficient number of bit positions are shifted, the binary point is eliminated from Y increment. In this way, floating point arithmetic is avoided. The value of Y increment at the increased scale factor may be used to derive a cumulative Y for each respective coordinate X values by iteratively incrementing Y increment by Y increment to produce a first cumulative Y and then incrementing that first cumulative Y with Y increment and so on to produce a series of distinct cumulative Y values at the higher scale factor for each X coordinate. The discrete cumulate Y values may then be reduced by the scale factor to the scale of the numerator (dx) before shifting and added to the initial Y coordinate value to produce the correct Y coordinate for each respective X coordinate. By producing the cumulative Y using Y increment at the increased scale factor, errors in the Y coordinate value due to an error in the cumulative Y increment due to the lower scale factor of Y increment are avoided.

The compiler used in the preferred embodiment to perform the method described herein is shown in the following program listings written in Motorola 68000 assembler language and contained within six modules.

The first module is the main program utilizing the control modules shown as modules 2-7. Its function is to access the pack data and interpret the knot locations and control codes therein.

Module 2 is a subset of module 1 and is used to evaluate each complete information set, identifying the Case and control code value thereof.

Module 3 is the compiler described earlier, which functions according to equations 3.1 and 3.2. and which compiles the knot locations, the angles of the curve at the knots, and the related values of the parameter t to produce the node locations on the curve segment locus.

Module 4 is the compiler which operates according to the method of auto-scaling linear interpolation shown herein.

Module 5 is a module which receives curve coordinate data, corresponding to the display coordinate system and sorts this data in the order of the raster lines on the display, so that the display data is accessed in timed relation to the generation of the raster lines, with data for display on any one particular raster line accessed in time with the location of the imaging beam at that raster line.

Module 6 is a general purpose memory allocation and release mechanism for buffer and raster line data.

Module 7 is an apparatus for performing general trigonometry.

As said, these modules are written in 68000 assembler code as used in the preferred embodiment to perform the invention as described. The language for the preferred embodiment is further compiled into machine object language for use on the Motorola 68000.

With respect to the system generally shown in Figure 10, there is illustrated a general type of apparatus with which the invention can be practiced. More particularly, in one aspect the CPU 1 is a microprocessor arrangement made up of, for example, a Motorola 68000 processor. The processor will be used to control the encoded information in data store 5. The data store can reside in part, for example, Magnetic Disc, CD ROM, Magnetic Tape, ROM, RAM, Networked Data Base Systems, other magnetic media or the like encodable media. It is to be understood that the above-identified specific elements are encompassed in said data store 5. Control and initiation of the process can be effected, for example, by a keyboard 3 through which instructions can be given. The processor controls the imaging apparatus 7.

In a specific aspect, the arrangement described is especially adapted for use as a phototypsetter of the type using conventional laser raster scan technology. Alternatively, the system of Figure 10 can also correspond to a desktop computer with CRT display.

D E C O D E   A   S E R I E S   O F   L O O P S

```
                                   DECODE  IDNT      1,0 CURVE FONT DECODER

                                           XDEF      DECODE

                                           XREF      FINAL_HERMITE,HERMITE,INIT_HERMITE
                                           XREF      GET_PQ,GETNIB34,GET_NIB4

                                   *                 STACK TEMPORARIES
00000000                                             OFFSET  0
00000000                       +                     DS.W    1
FFFFFFFE                       +   X_HOME:           SET     -*            * X HOME POSITION
00000002                       +                     DS.W    1
FFFFFFFC                       +   Y_HOME:           SET     -*            * Y HOME POSITION
00000004                       +                     DS.B    1
FFFFFFFB                       +   FINAL:            SET     -*            * LAST TIME IF TRUE
00000005                       +                     DS.B    1
FFFFFFFA                       +   X_DIR:            SET     -*            * X DIRECTION
00000006                       +                     DS.B    1
FFFFFFF9                       +   Y_DIR:            SET     -*            * Y DIRECTION
00000008                       +                     DS.W    0
FFFFFFF8                       +   LOCALS:           SET     -*            * NUMBER OF BYTES USED

                                   NEW_VALUE:        MACRO            NEW_VALUE X_OR_Y,X_NEW!Y_NEW!X_CUR!Y_CUR
                                           JSR       GETNIB34
                                           LSR.W     #1,D7
                                           SCS       \1_DIR(A6)
                                           SUB.W     \1_HOME(A6),D7
                                           MOVE.W    D7,\2
                                           ENDM
                               +
9:000000                       +           SECTION   09               * CODE SECTION
9:000000                           DECODE: EQU       *
9:000000   4E56FFF8                        LINK      A6,#LOCALS
9:000004   4850                            PEA       (A0)
9:000006   48A7F800                        MOVEM.W   D0/D1/D2/D3/D4,-(SP)
9:00000A   3D7C0250FFFE                    MOVE.W    #592,X_HOME(A6)
9:000010   3D7C02DFFFFC                    MOVE.W    #735,Y_HOME(A6)
9:000016   422EFFFB                        CLR.B     FINAL(A6)
```

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```
N E W    L O O P
  38  9:00001A                         NEW_LOOP: EQU   *
  39  9:00001A  4EB900000000                     JSR     GETNIB34
  40  9:000020  661A                             BNE.S   ORG_OK
  41  9:000022  4EB900000000                     JSR     GETNIB34
  42  9:000028  3D47FFFE                         MOVE.W  D7,X_HOME(A6)
  43  9:00002C  4EB900000000                     JSR     GETNIB34
  44  9:000032  3D47FFFC                         MOVE.W  D7,Y_HOME(A6)
  45  9:000036  4EB900000000                     JSR     GETNIB34
  46  9:00003C                         ORG_OK:   EQU     *
  47  9:00003C  E24F                             LSR.W   #1,D7
  48  9:00003E  55EEFFFA                         SCS     X_DIR(A6)
  49  9:000042  9E6EFFFE                         SUB.W   X_HOME(A6),D7
  50  9:000046  3007                             MOVE.W  D7,D0
  51  9:000048  4EB900000000     +               JSR     GETNIB34
  51  9:00004E  E24F             +               LSR.W   #1,D7
  51  9:000050  55EEFFF9         +               SCS     Y_DIR(A6)
  51  9:000054  9E6EFFFC         +               SUB.W   Y_HOME(A6),D7
  51  9:000058  3207             +               MOVE.W  D7,D1
  52  9:00005A  4847                             SWAP    D7
  53  9:00005C  3E00                             MOVE.W  D0,D7
  54  9:00005E  4EB900000000                     JSR     INIT_HERMITE
  55  9:000064                         NEXT_KNOT: EQU  *
  56  9:000064  3400                             MOVE.W  D0,D2
  57  9:000066  3601                             MOVE.W  D1,D3
  58  9:000068  7800                             MOVEQ.L #0,D4
  59                             +
  60  9:00006A                         SAME_KNOT: EQU  *
  61  9:00006A  4EB900000000                     JSR     GET_PQ
  62  9:000070  4A47                             TST.W   D7
  63  9:000072  674A                             BEQ.S   DO_CONTROL
  64  9:000074  4A2EFFFA                         TST.B   X_DIR(A6)
  65  9:000078  6704                             BEQ.S   INC_X
  66  9:00007A  9447                             SUB.W   D7,D2
  67  9:00007C  6002                             BRA.S   REL_Y
  68  9:00007E  D447                   INC_X:    ADD.W   D7,D2
  69  9:000080  4A2EFFF9               REL_Y:    TST.B   Y_DIR(A6)
  70  9:000084  6704                             BEQ.S   INC_Y
  71  9:000086  9646                             SUB.W   D6,D3
  72  9:000088  6002                             BRA.S   SEND_KNOT
  73  9:00008A  D646                   INC_Y:    ADD.W   D6,D3
  74                             +
  75  9:00008C                         SEND_KNOT: EQU  *
  76  9:00008C  3002                             MOVE.W  D2,D0
  77  9:00008E  3203                             MOVE.W  D3,D1
  78  9:000090  3C04                             MOVE.W  D4,D6
  79  9:000092  3E01                             MOVE.W  D1,D7
  80  9:000094  4847                             SWAP    D7
  81  9:000096  3E00                             MOVE.W  D0,D7
  82  9:000098  4EB900000000                     JSR     HERMITE
  83  9:00009E  60C4                             BRA.S   NEXT_KNOT
```

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```
E N D    L O O P
9:0000A0                     END_LAST: EQU     *
9:0000A0  522EFFFB                   ADDQ.B  #1,FINAL(A6)
9:0000A4                     END_LOOP: EQU     *
9:0000A4  4EB900000000               JSR     FINAL_HERMITE
9:0000AA  6608                       BNE.S   LOOP_DONE
9:0000AC  4A2EFFFB                   TST.B   FINAL(A6)
9:0000B0  6700FF68                   BEQ     NEW_LOOP
9:0000B4  4C9F001F           LOOP_DONE MOVEM.W (SP)+,D0/D1/D2/D3/D4
9:0000B8  205F                       MOVE.L  (SP)+,A0
9:0000BA  4E5E                       UNLK    A6
9:0000BC  4E75                       RTS
                   +
9:0000BE                     DO_CONTROL: EQU *
9:0000BE  3E06                       MOVE.W  D6,D7
9:0000C0  6B06                       BMI.S   CASE_DEFAULT
9:0000C2  0C470008                   CMPI.W  #8,D7
9:0000C6  6F02                       BLE.S   CASE_OK
9:0000C8                     CASE_DEFAULT: EQU *
9:0000C8  7E08                       MOVEQ.L #8,D7
9:0000CA                     CASE_OK: EQU      *
9:0000CA  DE47     +                 ADD.W   D7,D7
9:0000CC  4EFB7002                   JMP     CASE_TBL(PC,D7.W)

                             CASE_TBL:
9:0000D0  60CE                       BRA.S   END_LAST
9:0000D2  600E                       BRA.S   HORIZONTAL
9:0000D4  6024                       BRA.S   VERTICAL
9:0000D6  600A                       BRA.S   DIAGONAL
9:0000D8  60CA                       BRA.S   END_LOOP
9:0000DA  6034                       BRA.S   X_NEGATE
9:0000DC  603E                       BRA.S   Y_NEGATE
9:0000DE  6038                       BRA.S   XY_NEGATE
9:0000E0  6042                       BRA.S   DEFAULT
```



```
-|-
NTAL / VERTICAL / DIAGONAL
 9:0000E2                          HORIZONTAL: EQU  *
 9:0000E2                          DIAGONAL: EQU    *
 9:0000E2  1006                            MOVE.B  D6,D0
 9:0000E4  4EB900000000     +              JSR     GETNIB34
 9:0000EA  E24F             +              LSR.W   #1,D7
 9:0000EC  55EEFFFA         +              SCS     X_DIR(A6)
 9:0000F0  9E6EFFFE         +              SUB.W   X_HOME(A6),D7
 9:0000F4  3407             +              MOVE.W  D7,D2
 9:0000F6  5300                            SUBQ.B  #1,D0
 9:0000F8  6792                            BEQ     SEND_KNOT
 9:0000FA                          VERTICAL EQU     *
 9:0000FA  4EB900000000     +              JSR     GETNIB34
 9:000100  E24F             +              LSR.W   #1,D7
 9:000102  55EEFFF9         +              SCS     Y_DIR(A6)
 9:000106  9E6EFFFC         +              SUB.W   Y_HOME(A6),D7
 9:00010A  3607             +              MOVE.W  D7,D3
 9:00010C  6000FF7E                        BRA     SEND_KNOT
                            +
 9:000110                          X_NEGATE: EQU    *
 9:000110  462EFFFA                        NOT.B   X_DIR(A6)
 9:000114  6000FF54                        BRA     SAME_KNOT
 9:000118                          XY_NEGATE: EQU   *
 9:000118  462EFFFA                        NOT.B   X_DIR(A6)
 9:00011C                          Y_NEGATE: EQU    *
 9:00011C  462EFFF9                        NOT.B   Y_DIR(A6)
 9:000120  6000FF48                        BRA     SAME_KNOT
                            +
 9:000124                          DEFAULT: EQU     *
 9:000124  7801                            MOVEQ.L #1,D4
 9:000126  C806                            AND.B   D6,D4
 9:000128  5204                            ADDQ.B  #1,D4
 9:00012A  E14C                            LSL.W   #8,D4
 9:00012C  02060002                        ANDI.B  #2,D6
 9:000130  E206                            ASR.B   #1,D6
 9:000132  5206                            ADDQ.B  #1,D6
 9:000134  1806                            MOVE.B  D6,D4
 9:000136  6000FF32                        BRA     SAME_KNOT

                                           END
```


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```
N I B B L E
                                  NIBBLE   IDNT       1,0 CURVE FONT LOOP DATA HANDLER
                                           XDEF       GET_PQ,GETNIB34,GET_NIB4
                               +
                                  *        G E T _ P Q
                                  *
9:000000                       +           SECTION 09              * CODE SECTION
9:000000                          GET_PQ:  EQU        *
9:000000   6172                            BSR.S      GET_NIB1
9:000002   3C07                            MOVE.W     D7,D6
9:000004   E447                            ASR.W      #2,D7
9:000006   DE47                +           ADD.W      D7,D7              MAKE OFFSET INTO CASE_JMP
9:000008   4EFB7002                        JMP        CASE_BRA(PC,D7.W)

9:00000C   6006                   CASE_BRA: BRA.S     CASE_0
9:00000E   6014                            BRA.S      CASE_1
9:000010   6026                            BRA.S      CASE_2
9:000012   6040                            BRA.S      CASE_3
```

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```
 P Q
9:000014  4A46              CASE_0  TST.W    D6
9:000016  6608                      BNE.S    CTPQ_0
9:000018  615A                      BSR.S    GET_NIB1
9:00001A  6702                      BEQ.S    *+4
9:00001C  5647                      ADDQ.W   #3,D7
9:00001E  CD47                      EXG      D6,D7
9:000020  7E00              CTPQ_0  MOVEQ.L  #0,D7
9:000022  4E75                      RTS

9:000024  614E              CASE_1  BSR.S    GET_NIB1
9:000026  0C470008                  CMPI.W   #8,D7
9:00002A  6D06                      BLT.S    CTPQ_1
9:00002C  02470007                  ANDI.W   #7,D7
9:000030  603C                      BRA.S    CTPQ_9
9:000032  0A460004          CTPQ_1  EORI.W   #4,D6
9:000036  6036                      BRA.S    CTPQ_9

9:000038  613A              CASE_2  BSR.S    GET_NIB1
9:00003A  E24E                      LSR.W    #1,D6
9:00003C  6404                      BCC.S    *+6
9:00003E  06470010                  ADDI.W   #010,D7
9:000042  3F07                      MOVE.W   D7,-(SP)
9:000044  612E                      BSR.S    GET_NIB1
9:000046  E24E                      LSR.W    #1,D6
9:000048  6404                      BCC.S    *+6
9:00004A  06470010                  ADDI.W   #010,D7
9:00004E  3C07                      MOVE.W   D7,D6
9:000050  3E1F                      MOVE.W   (SP)+,D7
9:000052  601A                      BRA.S    CTPQ_9

9:000054  611E              CASE_3  BSR.S    GET_NIB1
9:000056  0A46000C                  EORI.W   #0C,D6
9:00005A  E94E                      LSL.W    #4,D6
9:00005C  8C47                      OR.W     D7,D6
9:00005E  6140                      BSR.S    GET_NIB2
9:000060  CD47                      EXG      D6,D7
9:000062  4A06                      TST.B    D6
9:000064  6A08                      BPL.S    CTPQ_9
9:000066  00470040                  ORI.W    #040,D7
9:00006A  0246007F                  ANDI.W   #07F,D6
9:00006E  5286              CTPQ_9  ADDQ.L   #1,D6
9:000070  5287                      ADDQ.L   #1,D7
9:000072  4E75                      RTS
```

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```
1   N I B B L E
                                         *        G E T _ N I B 1
                                         *
7:000000                            +             SECTION 07            * DATA SECTION:
7:000000                                 NIB:     DS.B     1
7:000002                            +             DS.W     0
):000074                            +             SECTION 09            * CODE SECTION
):000074   3E2D0028                      GET_NIB1 MOVE.W NIB_CNT(A5),D7
):000078   E44F                                   LSR.W    #2,D7
):00007A   651A                                   BCS.S    GNB1_1
):00007C   206D0000                               MOVE.L   NIB_PTR(A5),A0
):000080   1E307000                               MOVE.B   0(A0,D7.W),D7
):000084   13C700000000                           MOVE.B   D7,NIB
):00008A   546D0028                      GNB1_0:  ADDQ.W   #2,NIB_CNT(A5)
):00008E   0247000F                               ANDI.W   #0F,D7
):000092   48C7                                   EXT.L    D7
):000094   4E75                                   RTS
):000096   1E3900000000                  GNB1_1:  MOVE.B   NIB,D7
):00009C   E00F                                   LSR.B    #4,D7
):00009E   60EA                                   BRA      GNB1_0
                                    +
                                         *        G E T _ N I B 2
                                         *
):0000A0   3E2D0028                      GET_NIB2 MOVE.W NIB_CNT(A5),D7
):0000A4   E44F                                   LSR.W    #2,D7
):0000A6   6512                                   BCS.S    GNB2_1
):0000A8   586D0028                               ADDQ.W   #4,NIB_CNT(A5)
):0000AC   206D0000                               MOVE.L   NIB_PTR(A5),A0
):0000B0   41F07000                               LEA.L    0(A0,D7.W),A0
):0000B4   7E00                                   MOVEQ.L  #0,D7
):0000B6   1E10                                   MOVE.B   (A0),D7
):0000B8   4E75                                   RTS
):0000BA   61DA                          GNB2_1   BSR      GNB1_1
):0000BC   3F07                                   MOVE.W   D7,-(SP)
):0000BE   61B4                                   BSR      GET_NIB1
9:0000C0   E94F                          GNB3_0   LSL.W    #4,D7
9:0000C2   8E5F                                   OR.W     (SP)+,D7
9:0000C4   4E75                                   RTS
```

dule -II-

```
E T   3  N I B B L E S
                                 *       G E T _ N I B 3
                                 *
     9:0000C6  7E02              GET_NIB3: MOVEQ.L #2,D7
     9:0000C8  CE6D0028                    AND.W   NIB_CNT(A5),D7
     9:0000CC  6708                        BEQ.S   GNB3_1
     9:0000CE  61A4                        BSR     GET_NIB1
     9:0000D0  3F07                        MOVE.W  D7,-(SP)
     9:0000D2  61CC                        BSR     GET_NIB2
     9:0000D4  60EA                        BRA     GNB3_0
     9:0000D6  61C8              GNB3_1    BSR     GET_NIB2
     9:0000D8  3F07                        MOVE.W  D7,-(SP)
     9:0000DA  6198                        BSR     GET_NIB1
     9:0000DC  E14F              GNB4_0    LSL.W   #8,D7
     9:0000DE  8E5F                        OR.W    (SP)+,D7
     9:0000E0  4E75                        RTS
                             +
                                 *       G E T N I B 3 4
                                 *
     9:0000E2  7E01              GETNIB34: MOVEQ.L #1,D7
     9:0000E4  CE6D0028                    AND.W   NIB_CNT(A5),D7
     9:0000E8  67DC                        BEQ     GET_NIB3
                                 *         BRA     GET_NIB4
                             +
                                 *       G E T _ N I B 4
                                 *
     9:0000EA  61B4              GET_NIB4: BSR     GET_NIB2
     9:0000EC  3F07                        MOVE.W  D7,-(SP)
     9:0000EE  61B0                        BSR     GET_NIB2
     9:0000F0  60EA                        BRA     GNB4_0

                                           END
```

Module -III-


```
H E R M I T E   CURVE PROCESSOR
 2                                      HERMITE IDNT    1,0 CURVE FONT HERMITE SPLINE GENERATOR
 6                             +
 7                                              XDEF    INIT_HERMITE,HERMITE,FINAL_HERMITE       ENTRY POINTS
 8                                              XDEF    SCALE,SET_BETA,GAMMA_ALPHA,MAKE_NODES    STATIC SUBROUTINE
 9                                              XDEF    SCALE,PREV,CUR,NEXT,FIRST,SECOND         VARIABLES
10                                              XREF    PLOT_CHECK
11
12  0000007F                            LINEAR_IMPLIED: SET     127
13  00000001                            ISLINEAR:       SET     1
14  00000002                            CURVE:          SET     2
15  00000050                            CUSP_IMPLIED:   SET     40*2
16  00000001                            ISCUSP:         SET     1
17  00000002                            CONTICIOUS:     SET     2
18  0000005A                            HDEG_45:        SET     45*2
19  000000B4                            HDEG_90:        SET     90*2
20  00000168                            HDEG_180:       SET     180*2
21  00004000                            R_S_2:          SET     $4000
22  00007FFF                            R_S_4:          SET     $7FFF
23  00000003                            T_TOOFAR:       SET     3
24  00000006                            T_DECREMENT:    SET     3*SHORT
25  0000000A                            T_INCREMENT:    SET     5*SHORT
26  00000800                            T_LENGTH:       SET     1024*SHORT
27  00000666                            XI_LIMIT:       SET     1638
28  00000000                   +        GAINSV_SCALE:     SET   0                   GAIN SCALE FACTOR
28  00000008                   +        GAINSS_SCALE:     SET   8
28  000000FF                   +        GAINSM_SCALE:     SET (1<<8-1)<<0
29  00000000                   +        R_SSV_SCALE:      SET   0                   R/S SCALE
29  0000000D                   +        R_SSS_SCALE:      SET   13
29  00001FFF                   +        R_SSM_SCALE:      SET (1<<13-1)<<0
30  00000000                   +        SINESV_SCALE:     SET   0                   SINE/COSINE SCALE
30  0000000F                   +        SINESS_SCALE:     SET   15
30  00007FFF                   +        SINESM_SCALE:     SET (1<<15-1)<<0
31  00000000                   +        TIMESV_SCALE:     SET   0                   TIME FUNCTION SCALE
31  0000000F                   +        TIMESS_SCALE:     SET   15
31  00007FFF                   +        TIMESM_SCALE:     SET (1<<15-1)<<0
```

```
T A T I C   D A T A   A R E A
 33                                         *       KNOT STRUCTURE
 34  00000000                                       OFFSET  0
 35  00000000                         +     MIS_Y:          DS.W    1
 35  00000002                         +     MIS_X:          DS.W    1
 36  00000004                         +     DRU_Y:          DS.W    1
 36  00000006                         +     DRU_X:          DS.W    1
 37  00000008                               ALPHA:          DS.W    1
 38  0000000A                               BETA:           DS.W    1
 39  0000000C                               GAMMA:          DS.W    1
 40  0000000E                               CUSP:           DS.B    1
 41  0000000F                               LINEAR:         DS.B    1
 42  00000010                         +             DS.W    0
 43  00000010                               KNOT_LENGTH: EQU *
 44  7:000000                         +             SECTION 07              * DATA SECTION
 45  7:000000                         +             DS.W    0
 46  7:000000  0000000000000000             PREV:   DCB.B   KNOT_LENGTH,0
 47  7:000010  0000000000000000             CUR:    DCB.B   KNOT_LENGTH,0
 48  7:000020  0000000000000000             NEXT:   DCB.B   KNOT_LENGTH,0
 49  7:000030  0000000000000000             FIRST:  DCB.B   KNOT_LENGTH,0
 50  7:000040  0000000000000000             SECOND: DCB.B   KNOT_LENGTH,0
 51                                   +
 52                                         *       I N I T _ H E R M I T E
 53                                         *
 54  9:000000                         +             SECTION 09              * CODE SECTION
 55  9:000000  4851                         INIT_HERMITE: PEA (A1)
 56  9:000002  43F900000000                         LEA.L   PREV,A1
 57  9:000008  426D002A                             CLR.W   KNOT_CNT(A5)
 58  9:00000C  23470004                             MOVE.L  D7,DRU_Y(A1)
 59  9:000010  6104                                 BSR.S   SCALE
 60  9:000012  225F                                 MOVE.L  (SP)+,A1
 61  9:000014  4E75                                 RTS
```

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```
S C A L E ---   SLANT / ROTATE / TRANSLATE / SCALE
                                        *       S C A L E
                                        *
    9:000016                   +                SECTION 09           * CODE SECTION
    9:000016                            SCALE:  EQU      *
    9:000016  48E7C000                          MOVEM.L  D0/D1,-(SP)
    9:00001A  32290004                          MOVE.W   DRU_Y(A1),D1
    9:00001E  30290006                          MOVE.W   DRU_X(A1),D0
    9:000022  3E2D0004                          MOVE.W   SLANT(A5),D7
    9:000026  6712                              BEQ.S    SCAL_1
    9:000028  4EB900000000                      JSR      SINE
    9:00002E  CFC1                              MULS     D1,D7
    9:000030  E387                 +            ASL.L    #16-SINE08_SCALE,D7
    9:000032  4847                 +            SWAP     D7
    9:000034  D047                              ADD.W    D7,D0
    9:000036  33470006                          MOVE.W   D7,DRU_X(A1)
    9:00003A  926D000C                  SCAL_1: SUB.W    ROT_Y(A5),D1
    9:00003E  906D000E                          SUB.W    ROT_X(A5),D0
    9:000042  3E2D0006                          MOVE.W   ROTATE(A5),D7
    9:000046  6752                              BEQ.S    SCAL_6
    9:000048  0C4700B4                          CMPI.W   #HDEG_90,D7
    9:00004C  6606                              BNE.S    SCAL_2
    9:00004E  C141                              EXG      D0,D1
    9:000050  4440                              NEG.W    D0
    9:000052  6046                              BRA.S    SCAL_6
    9:000054  0C47FF4C                  SCAL_2: CMPI.W   #-HDEG_90,D7
    9:000058  6606                              BNE.S    SCAL_3
    9:00005A  C141                              EXG      D0,D1
    9:00005C  4441                              NEG.W    D1
    9:00005E  603A                              BRA.S    SCAL_6
    9:000060  0C470168                  SCAL_3: CMPI.W   #HDEG_180,D7
    9:000064  6706                              BEQ.S    SCAL_4
    9:000066  0C47FE98                          CMPI.W   #-HDEG_180,D7
    9:00006A  6606                              BNE.S    SCAL_5
    9:00006C  4440                      SCAL_4: NEG.W    D0
    9:00006E  4441                              NEG.W    D1
    9:000070  6028                              BRA.S    SCAL_6
```

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```
S C A L E ---   SLANT / ROTATE / TRANSLATE / SCALE
   99  9:000072  4EB900000000          SCAL_5: JSR      COSINE
  100  9:000078  3F07                          MOVE.W   D7,-(SP)
  101  9:00007A  3E2D0006                      MOVE.W   ROTATE(A5),D7
  102  9:00007E  4EB900000000                  JSR      SINE
  103  9:000084  3C00                          MOVE.W   D0,D6
  104  9:000086  CDC7                          MULS     D7,D6
  105  9:000088  CFC1                          MULS     D1,D7
  106  9:00008A  C3D7                          MULS     (SP),D1
  107  9:00008C  D286                          ADD.L    D6,D1
  108  9:00008E  E381            +             ASL.L    #16-SINE08_SCALE,D1
  108  9:000090  4841            +             SWAP     D1
  109  9:000092  C1DF                          MULS     (SP)+,D0
  110  9:000094  9087                          SUB.L    D7,D0
  111  9:000096  E380            +             ASL.L    #16-SINE08_SCALE,D0
  111  9:000098  4840            +             SWAP     D0
  112  9:00009A  D06D0012              SCAL_6: ADD.W    ORG_X(A5),D0
  113  9:00009E  C1ED000A                      MULS     GAIN_X(A5),D0
  114  9:0000A2  E080            +             ASR.L    #GAIN08_SCALE,D0
  115  9:0000A4  D06D0016                      ADD.W    OFST_X(A5),D0
  120  9:0000A8  33400002                      MOVE.W   D0,MIS_X(A1)
  122  9:0000AC  D26D0010                      ADD.W    ORG_Y(A5),D1
  123  9:0000B0  C3ED0008                      MULS     GAIN_Y(A5),D1
  124  9:0000B4  E081            +             ASR.L    #GAIN08_SCALE,D1
  125  9:0000B6  D26D0014                      ADD.W    OFST_Y(A5),D1
  127  9:0000BA  3281                          MOVE.W   D1,(A1)
  132  9:0000BC  4CDF0003                      MOVEM.L  (SP)+,D0/D1
  133  9:0000C0  4E75                          RTS
```

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```
H E R M I T E
                                          *       H E R M I T E
                                          *
9:0000C2                            +             SECTION 09          * CODE SECTION
9:0000C2                                  HERMITE: EQU     *
9:0000C2  48E70060                                 MOVEM.L A1/A2,-(SP)
9:0000C6  45F?00000010                             LEA.L   CUR,A2
9:0000CC  4A6D002A                                 TST.W   KNOT_CNT(A5)
9:0000D0  6613                                     BNE.S   HRMT_1
9:0000D2  25470004                                 MOVE.L  D7,DRU_Y+CUR-CUR(A2)
9:0000D6  3546FFFE                                 MOVE.W  D6,CUSP+PREV-CUR(A2)
9:0000DA  43D2                                     LEA.L   (A2),A1
9:0000DC  6100FF38                                 BSR     SCALE
9:0000E0  43EAFFF0                                 LEA.L   PREV-CUR(A2),A1
9:0000E4  610000A0                                 BSR     SET_BETA
9:0000E8  6044                                     BRA.S   HRMT_0
9:0000EA  25470014                        HRMT_1:  MOVE.L  D7,DRU_Y+NEXT-CUR(A2)
9:0000EE  3546000E                                 MOVE.W  D6,CUSP+CUR-CUR(A2)
9:0000F2  43EA0010                                 LEA.L   NEXT-CUR(A2),A1
9:0000F6  6100FF1E                                 BSR     SCALE
9:0000FA  C549                                     EXG     A2,A1
9:0000FC  61000086                                 BSR     SET_BETA
9:000100  7C10                                     MOVEQ.L #NEXT-CUR,D6
9:000102  45D1                                     LEA.L   (A1),A2
9:000104  43EAFFF0                                 LEA.L   PREV-CUR(A2),A1
9:000108  61000130                                 BSR     GAMMA_ALPHA
9:00010C  672A                                     BEQ.S   HRMT_4
9:00010E  0C6D0001002A                             CMPI.W  #2-1,KNOT_CNT(A5)
9:000114  672E                                     BEQ.S   HRMT_5
9:000116  61000250                                 BSR     MAKE_NODES
```

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```
H E R M I T E
 165  9:00011A  43EAFFF0               HRMT_2: LEA.L    PREV-CUR(A2),A1
 166  9:00011E  22DA             +             MOVE.L   (A2)+,(A1)+
 166  9:000120  22DA             +             MOVE.L   (A2)+,(A1)+
 166  9:000122  22DA             +             MOVE.L   (A2)+,(A1)+
 166  9:000124  22DA             +             MOVE.L   (A2)+,(A1)+
 169  9:000126                         HRMT_3: EQU      *
 170  9:000126  22DA             +             MOVE.L   (A2)+,(A1)+
 170  9:000128  22DA             +             MOVE.L   (A2)+,(A1)+
 170  9:00012A  22DA             +             MOVE.L   (A2)+,(A1)+
 170  9:00012C  22DA             +             MOVE.L   (A2)+,(A1)+
 171  9:00012E  4CDF0600               HRMT_0: MOVEM.L  (SP)+,A1/A2
 172  9:000132  526D002A                       ADDQ.W   #1,KNOT_CNT(A5)
 173  9:000136  4E75                           RTS
 174  9:000138                         HRMT_4: EQU      *
 175  9:000138  45EA0010         +             LEA.L    NEXT-CUR(A2),A2
 176  9:00013C  6148                           BSR.S    SET_BETA
 177  9:00013E  43EAFFF0                       LEA.L    CUR-NEXT(A2),A1
 178  9:000142  60E2                           BRA      HRMT_3
 179  9:000144  3E2A000A               HRMT_5: MOVE.W   BETA(A2),D7
 180  9:000148  9E69000A                       SUB.W    BETA(A1),D7
 181  9:00014C  4EB900000000                   JSR      FOLD_ANGLE
 182  9:000152  5EED002F                       SGT      INIT_COLOR(A5)
 184  9:000156  3E12                           MOVE.W   (A2),D7
 185  9:000158  BE51                           CMP.W    (A1),D7
 191  9:00015A  5DC7                           SLT      D7
 192  9:00015C  6606                           BNE.S    HRMT_6
 193  9:00015E  BE2D002F                       CMP.B    INIT_COLOR(A5),D7
 194  9:000162  57C7                           SEQ      D7
 195  9:000164  1B47002E               HRMT_6  MOVE.B   D7,COLOR(A5)
 196  9:000168  43EA0020                       LEA.L    FIRST-CUR(A2),A1
 197  9:00016C  45EAFFF0         +             LEA.L    PREV-CUR(A2),A2
 198  9:000170  22DA             +             MOVE.L   (A2)+,(A1)+
 198  9:000172  22DA             +             MOVE.L   (A2)+,(A1)+
 198  9:000174  22DA             +             MOVE.L   (A2)+,(A1)+
 198  9:000176  22DA             +             MOVE.L   (A2)+,(A1)+
 201  9:000178  22DA             +             MOVE.L   (A2)+,(A1)+
 201  9:00017A  22DA             +             MOVE.L   (A2)+,(A1)+
 201  9:00017C  22DA             +             MOVE.L   (A2)+,(A1)+
 201  9:00017E  22DA             +             MOVE.L   (A2)+,(A1)+
 201  9:000180  45EAFFF0         +             LEA.L    -(KNOT_LENGTH)(A2),A2
 202  9:000184  6094                           BRA      HRMT_2
```

```
SET   BETA
 204                                        *        S E T _ B E T A
 205                                        *
 206  9:000186                        +              SECTION  9          * CODE SECTION
 207  9:000186                              SET_BETA EQU      *
 208  9:000186  3E2A0004                             MOVE.W   DRU_Y(A2),D7
 209  9:00018A  9E690004                             SUB.W    DRU_Y(A1),D7
 210  9:00018E  4847                                 SWAP     D7
 211  9:000190  3E2A0006                             MOVE.W   DRU_X(A2),D7
 212  9:000194  9E690006                             SUB.W    DRU_X(A1),D7
 213  9:000198  2F07                                 MOVE.L   D7,-(SP)
 214  9:00019A  4EB900000000                         JSR      ARCTAN
 215  9:0001A0  DE6D0006                             ADD.W    ROTATE(A5),D7
 216  9:0001A4  3347000A                             MOVE.W   D7,BETA(A1)
 217  9:0001A8  4A29000F                             TST.B    LINEAR(A1)
 218  9:0001AC  6622                                 BNE.S    SBETA_4
 219  9:0001AE  3E1F                                 MOVE.W   (SP)+,D7
 220  9:0001B0  6A02                  +              BPL.S    *+4
 220  9:0001B2  4447                  +              NEG.W    D7
 221  9:0001B4  0C47007F                             CMPI.W   #LINEAR_IMPLIED,D7
 222  9:0001B8  620E                                 BHI.S    SBETA_2
 223  9:0001BA  3E1F                                 MOVE.W   (SP)+,D7
 224  9:0001BC  6A02                  +              BPL.S    *+4
 224  9:0001BE  4447                  +              NEG.W    D7
 225  9:0001C0  0C47007F                             CMPI.W   #LINEAR_IMPLIED,D7
 226  9:0001C4  6204                                 BHI.S    SBETA_3
 227  9:0001C6  4E75                                 RTS
 228  9:0001C8                              SBETA_2  EQU      *
 229  9:0001C8  548F                  +              ADDQ.L   #SHORT,SP
 230  9:0001CA  5229000F                    SBETA_3  ADDQ.B   #ISLINEAR,LINEAR(A1)
 231  9:0001CE  4E75                                 RTS
 232  9:0001D0                              SBETA_4  EQU      *
 233  9:0001D0  588F                  +              ADDQ.L   #LONG,SP
 234  9:0001D2  4E75                                 RTS
```

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```
AL  H E R M I T E
                                    *       F I N A L _ H E R M I T E
                                    *
9:0001D4                    +               SECTION 09          * CODE SECTION
9:0001D4  7E01                      FHMT_1: MOVEQ.L #TRUE,D7
9:0001D6  1B47002D                          MOVE.B  D7,LOOP_NOT_CLOSED(A5)
9:0001DA  4E75                              RTS
9:0001DC                            FINAL_HERMITE: EQU *
9:0001DC  2E3900000034                      MOVE.L  FIRST+DRU_Y,D7
9:0001E2  BEB900000014                      CMP.L   CUR+DRU_Y,D7
9:0001E8  66EA                              BNE     FHMT_1
9:0001EA  48E7C060                          MOVEM.L D0/D1/A1/A2,-(SP)
9:0001EE  45F900000030                      LEA.L   FIRST,A2
9:0001F4  7C10                              MOVEQ.L #SECOND-FIRST,D6
9:0001F6  43EAFFD0                          LEA.L   PREV-FIRST(A2),A1
9:0001FA  613E                              BSR.S   GAMMA_ALPHA
9:0001FC  672E                              BEQ.S   FHMT_3
9:0001FE  61000168                          BSR     MAKE_NODES
9:000202  43D2                              LEA.L   (A2),A1
9:000204  45EA0010          +               LEA.L   SECOND-FIRST(A2),A2
9:000208  6100015E                  FHMT_2: BSR     MAKE_NODES
9:00020C  302D0020                          MOVE.W  OLD_RASTER(A5),D0
9:000210  322D0022                          MOVE.W  OLD_INTERCEPT(A5),D1
9:000214  D241                              ADD.W   D1,D1
9:000216  4A2D002E                          TST.B   COLOR(A5)
9:00021A  6702                              BEQ.S   *+4
9:00021C  5241                              ADDQ.W  #1,D1
9:00021E  4EB900000000                      JSR     PLOT_CHECK
9:000224  4CDF0603                          MOVEM.L (SP)+,D0/D1/A1/A2
9:000228  7E00                              MOVEQ.L #FALSE,D7
9:00022A  4E75                              RTS
9:00022C                            FHMT_3: EQU     *
9:00022C  45EA0010          +               LEA.L   SECOND-FIRST(A2),A2
9:000230  6100FF54                          BSR     SET_BETA
9:000234  7C00                              MOVEQ.L #SECOND-SECOND,D6
9:000236  6102                              BSR.S   GAMMA_ALPHA
9:000238  60CE                              BRA     FHMT_2
```

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```
GAMMA  ALPHA
 273                                          *       G A M M A _ A L P H A
 274                                          *
 275  9:00023A                         +              SECTION 09          * CODE SECTION
 276  9:00023A                                GAMMA_ALPHA: EQU *
 277  9:00023A  4A86                                  TST.L    D6
 278  9:00023C  6734                                  BEQ.S    CMAL_4
 279  9:00023E  3E2A000A                              MOVE.W   BETA(A2),D7
 280  9:000242  9E69000A                              SUB.W    BETA(A1),D7
 281  9:000246  6716                                  BEQ.S    CMAL_2
 287  9:000248  3E2A0002                              MOVE.W   MIS_X(A2),D7
 288  9:00024C  BE690002                              CMP.W    MIS_X(A1),D7
 290  9:000250  6614                                  BNE.S    CMAL_3
 291  9:000252  BE726802                              CMP.W    MIS_X(A2,D6.L),D7
 292  9:000256  6706                                  BEQ.S    CMAL_2
 294  9:000258  3E12                                  MOVE.W   (A2),D7
 295  9:00025A  BE51                                  CMP.W    (A1),D7
 301  9:00025C  6614                                  BNE.S    CMAL_4
 302  9:00025E  536D002A                      CMAL_2: SUBQ.W   #1,KNOT_CNT(A5)
 303  9:000262  7E00                                  MOVEQ.L  #FALSE,D7
 304  9:000264  4E75                                  RTS
 305  9:000266                                CMAL_3: EQU      *
 307  9:000266  3E12                                  MOVE.W   (A2),D7
 308  9:000268  BE51                                  CMP.W    (A1),D7
 314  9:00026A  6606                                  BNE.S    CMAL_4
 315  9:00026C  BE726800                              CMP.W    MIS_Y(A2,D6.L),D7
 316  9:000270  67EC                                  BEQ.S    CMAL_2
```

```
A   A L P H A
):000272  4A2A000E          CMAL_4: TST.B    CUSP(A2)
):000276  6622                      BNE.S    CMAL_6
):000278  3E2A000A                  MOVE.W   BETA(A2),D7
):00027C  9E69000A                  SUB.W    BETA(A1),D7
):000280  4EB900000000              JSR      FOLD_ANGLE
):000286  4A47                      TST.W    D7
):000288  6A02          +           BPL.S    *+4
9:00028A  4447          +           NEG.W    D7
9:00028C  0C470050                  CMPI.W   #CUSP_IMPLIED,D7
9:000290  6304                      BLS.S    CMAL_5
9:000292  532A000E                  SUBQ.B   #CONTIGIOUS-ISCUSP,CUSP(A2)
9:000296  542A000E          CMAL_5: ADDQ.B   #CONTIGIOUS,CUSP(A2)
9:00029A  4A6D0004          CMAL_6: TST.W    SLANT(A5)
9:00029E  660A                      BNE.S    CMAL6A
9:0002A0  3E2D0008                  MOVE.W   GAIN_Y(A5),D7
9:0002A4  BE6D000A                  CMP.W    GAIN_X(A5),D7
9:0002A8  673E                      BEQ.S    CMAL_8
9:0002AA  0C6D0001002A      CMAL6A  CMPI.W   #2-1,KNOT_CNT(A5)
9:0002B0  6618                      BNE.S    CMAL_7
9:0002B2  3E12                      MOVE.W   (A2),D7
9:0002B4  9E51                      SUB.W    (A1),D7
9:0002B6  4847                      SWAP     D7
9:0002B8  3E2A0002                  MOVE.W   MIS_X(A2),D7
9:0002BC  9E690002                  SUB.W    MIS_X(A1),D7
9:0002C0  4EB900000000              JSR      ARCTAN
9:0002C6  3347000A                  MOVE.W   D7,BETA(A1)
9:0002CA  4A86              CMAL_7: TST.L    D6
9:0002CC  671A                      BEQ.S    CMAL_8
9:0002CE  3E326800                  MOVE.W   MIS_Y(A2,D6.L),D7
9:0002D2  9E52                      SUB.W    (A2),D7
9:0002D4  4847                      SWAP     D7
9:0002D6  3E326802                  MOVE.W   MIS_X(A2,D6.L),D7
9:0002DA  9E6A0002                  SUB.W    MIS_X(A2),D7
9:0002DE  4EB900000000              JSR      ARCTAN
9:0002E4  3547000A                  MOVE.W   D7,BETA(A2)
```

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```
 A L P H A
02E8  0C2A0002000E          CMAL_8  CMPI.B   #CONTIGIOUS,CUSP(A2)
02EE  6656                          BNE.S    CMAL_13
02F0  3E2A000A                      MOVE.W   BETA(A2),D7
02F4  DE69000A                      ADD.W    BETA(A1),D7
02F8  E247                          ASR.W    #1,D7
02FA  35470008                      MOVE.W   D7,ALPHA(A2)
02FE  3E2A000A                      MOVE.W   BETA(A2),D7
0302  9E69000A                      SUB.W    BETA(A1),D7
0306  6A02             +            BPL.S    *+4
0308  4447             +            NEG.W    D7
030A  0C470168                      CMPI.W   #HDEG_180,D7
030E  6312                          BLS.S    CMAL_10
0310  3E2A0008                      MOVE.W   ALPHA(A2),D7
0314  6B04                          BMI.S    CMAL_9
0316  044702D0                      SUB.W    #HDEG_180*2,D7
031A  06470168              CMAL_9  ADD.W    #HDEG_180,D7
031E  35470008                      MOVE.W   D7,ALPHA(A2)
0322  336A0008000C          CMAL_10 MOVE.W   ALPHA(A2),GAMMA(A1)
0328  7E01                          MOVEQ.L  #ISLINEAR,D7
032A  BE29000F                      CMP.B    LINEAR(A1),D7
032E  6606                          BNE.S    CMAL_11
0330  3569000A0008                  MOVE.W   BETA(A1),ALPHA(A2)
0336  BE2A000F              CMAL_11 CMP.B    LINEAR(A2),D7
033A  6606                          BNE.S    CMAL_12
033C  336A000A000C                  MOVE.W   BETA(A2),GAMMA(A1)
0342  7E01                  CMAL_12 MOVEQ.L  #TRUE,D7
0344  4E75                          RTS
0346  3369000A000C          CMAL_13 MOVE.W   BETA(A1),GAMMA(A1)
034C  356A000A0008                  MOVE.W   BETA(A2),ALPHA(A2)
0352  60EE                          BRA      CMAL_12
```

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MAKE NODES

```
                                      *       M A K E _ N O D E S
                                      *
                                      *LOCALS
        00000000                              OFFSET  0
        00000000          +                           DS.W    1
        FFFFFFFE          +           X2_X1:          SET     -*
        00000002          +                           DS.W    1
        FFFFFFFC          +           Y2_Y1:          SET     -*
        00000004          +                           DS.W    1
        FFFFFFFA          +           T_STEP:         SET     -*
        00000006          +                           DS.W    0
        FFFFFFFA          +           LOCALS:         SET     -*

                                              XREF    NTRPLS
                                              XREF    ARCTAN,SINE,COSINE,FOLD_ANGLE
                                              XREF    TIME_1_TBL,TIME_2_TBL,XI_TBL
```

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```
MAKE  NODES
 418  9:000354                    +         SECTION 89            * CODE SECTION
 419  9:000354  4E5E                MKND_99 UNLK     A6
 420  9:000356  4C9F003F                    MOVEM.W (SP)+,D0/D1/D2/D3/D4/D5
 421  9:00035A                      MKND_1: EQU      *
 423  9:00035A  3C12                        MOVE.W   (A2),D6
 432  9:00035C  3E2A0002                    MOVE.W   MIS_X(A2),D7
 434  9:000360  4EB900000000                JSR      NTRPLS
 435  9:000366  4E75                        RTS
 436
 437  9:000368                      MAKE_NODES: EQU *
 439  9:000368  2B510020                    MOVE.L   (A1),PLOT_Y(A5)
 444  9:00036C  0C290001000F        MKND_2: CMPI.B   #ISLINEAR,LINEAR(A1)
 445  9:000372  67E6                        BEQ      MKND_1
 446  9:000374  3E29000A                    MOVE.W   BETA(A1),D7
 447  9:000378  BE690008                    CMP.W    ALPHA(A1),D7
 448  9:00037C  6606                        BNE.S    MKND_3
 449  9:00037E  BE69000C                    CMP.W    GAMMA(A1),D7
 450  9:000382  67D6                        BEQ      MKND_1
```

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Module -III-

```
MAKE NODES
  452  9:000384  48A7FC00              MKND_S   MOVEM.W D0/D1/D2/D3/D4/D5,-(SP)
  453  9:000388  4E56FFFA                        LINK    A6,#LOCALS
  454  9:00038C  9E690008                        SUB.W   ALPHA(A1),D7
  455  9:000390  4EB900000000                    JSR     FOLD_ANGLE
  456  9:000396  3007                            MOVE.W  D7,D0
  457  9:000398  3E29000C                        MOVE.W  GAMMA(A1),D7
  458  9:00039C  9E69000A                        SUB.W   BETA(A1),D7
  459  9:0003A0  4EB900000000                    JSR     FOLD_ANGLE
  460  9:0003A6  3207                            MOVE.W  D7,D1
  461  9:0003A8  6602                            BNE     *+4
  462  9:0003AA  3200                            MOVE.W  D0,D1
  463  9:0003AC  4A40                            TST.W   D0
  464  9:0003AE  6602                            BNE     *+4
  465  9:0003B0  3001                            MOVE.W  D1,D0
  466  9:0003B2  3E00                            MOVE.W  D0,D7
  467  9:0003B4  DE41                            ADD.W   D1,D7
  468  9:0003B6  E247                            ASR.W   #1,D7
  469  9:0003B8  6A02          +                 BPL.S   *+4
  469  9:0003BA  4447          +                 NEG.W   D7
  470  9:0003BC  0C47005A                        CMPI.W  #HDEG_45,D7
  471  9:0003C0  6306                            BLS.S   MKND_4
  472  9:0003C2  4447                            NEG.W   D7
  473  9:0003C4  064700B4                        ADDI.W  #HDEG_90,D7
  474  9:0003C8  41F900000000          MKND_4   LEA.L   XI_TBL,A0
  475  9:0003CE  DE47          +                 ADD.W   D7,D7
  476  9:0003D0  3E307000                        MOVE.W  0(A0,D7.W),D7
  477  9:0003D4  3407                            MOVE.W  D7,D2
  478  9:0003D6  0C470666                        CMPI.W  #XI_LIMIT,D7
  479  9:0003DA  6408          +                 BCC.S   MKND_5           * HIGH OR SAME
  480  9:0003DC  323C4000                        MOVE.W  #R_S_2,D1
  481  9:0003E0  3001                            MOVE.W  D1,D0
  482  9:0003E2  6042                            BRA.S   MKND_10
  483  9:0003E4  7C00                  MKND_5:  MOVEQ.L #0,D6
  484  9:0003E6  3C02                            MOVE.W  D2,D6
  485  9:0003E8  E586                            ASL.L   #2,D6
  486  9:0003EA  3E01                            MOVE.W  D1,D7
  487  9:0003EC  4EB900000000                    JSR     SINE
  488  9:0003F2  6A02          +                 BPL.S   *+4
  488  9:0003F4  4487          +                 NEG.L   D7
  489  9:0003F6  BE86                            CMP.L   D6,D7
  490  9:0003F8  6506          +                 BCS.S   MKND_6           * LOWER
  491  9:0003FA  3E3C7FFF                        MOVE.W  #R_S_4,D7
  492  9:0003FE  6006                            BRA.S   MKND_7
```

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```
MAKE  NODES
 494  9:000400  4847                MKND_6: SWAP    D7
 495  9:000402  E687                        ASR.L   #16-R_SOS_SCALE,D7
 496  9:000404  8EC2                        DIVU    D2,D7
 497  9:000406  3207                MKND_7: MOVE.W  D7,D1
 498  9:000408  3E00                        MOVE.W  D0,D7
 499  9:00040A  4EB900000000                JSR     SINE
 500  9:000410  6A02          +             BPL.S   *+4
 500  9:000412  4487          +             NEG.L   D7
 501  9:000414  BE86                        CMP.L   D6,D7
 502  9:000416  6506          +             BCS.S   MKND_8          * LOWER
 503  9:000418  3E3C7FFF                    MOVE.W  #R_S_4,D7
 504  9:00041C  6006                        BRA.S   MKND_9
 505  9:00041E  4847                MKND_8: SWAP    D7
 506  9:000420  E687                        ASR.L   #16-R_SOS_SCALE,D7
 507  9:000422  8EC2                        DIVU    D2,D7
 508  9:000424  3007                MKND_9: MOVE.W  D7,D0
 509  9:000426                      MKND_10 EQU     *
 514  9:000426  3C2A0002                    MOVE.W  MIS_X(A2),D6
 516  9:00042A  9C6D0022                    SUB.W   PLOT_X(A5),D6
 517  9:00042E  3D46FFFE                    MOVE.W  D6,X2_X1(A6)
 518  9:000432  6A02          +             BPL.S   *+4
 518  9:000434  4446          +             NEG.W   D6
 520  9:000436  3E12                        MOVE.W  (A2),D7
 525  9:000438  9E6D0020                    SUB.W   PLOT_Y(A5),D7
 526  9:00043C  3D47FFFC                    MOVE.W  D7,Y2_Y1(A6)
 527  9:000440  6A02          +             BPL.S   *+4
 527  9:000442  4447          +             NEG.W   D7
 528  9:000444  BE46                        CMP.W   D6,D7
 529  9:000446  620C                        BHI.S   MKND_11
 530  9:000448  3E29000A                    MOVE.W  BETA(A1),D7
 531  9:00044C  4EB900000000                JSR     COSINE
 532  9:000452  600C                        BRA.S   MKND_12
 533  9:000454  3C07                MKND_11 MOVE.W  D7,D6
 534  9:000456  3E29000A                    MOVE.W  BETA(A1),D7
 535  9:00045A  4EB900000000                JSR     SINE
 536  9:000460                      MKND_12 EQU     *
 537  9:000460  6A02          +             BPL.S   *+4
 537  9:000462  4487          +             NEG.L   D7
 538  9:000464  4846                        SWAP    D6
 539  9:000466  4246                        CLR.W   D6
 540  9:000468  E286                        ASR.L   #16-SINESS_SCALE,D6
 541  9:00046A  8CC7                        DIVU    D7,D6
 542  9:00046C  3406                        MOVE.W  D6,D2
 543  9:00046E  CCC1                        MULU    D1,D6
 544  9:000470  E386          +             ASL.L   #16-(R_SOS_SCALE+2),D6
 544  9:000472  4846          +             SWAP    D6
 545  9:000474  3206                        MOVE.W  D6,D1
 546  9:000476  3E02                        MOVE.W  D2,D7
 547  9:000478  CEC0                        MULU    D0,D7
 548  9:00047A  E387          +             ASL.L   #16-(R_SOS_SCALE+2),D7
 548  9:00047C  4847          +             SWAP    D7
 549  9:00047E  3007                        MOVE.W  D7,D0
 550  9:000480  3E290008                    MOVE.W  ALPHA(A1),D7
```

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```
M A K E   N O D E S
  551  9:000484  4EB900000000             JSR      COSINE
  552  9:00048A  CFC1                     MULS     D1,D7
  553  9:00048C  E787          +          ASL.L    #16-(SINESS_SCALE-2),D7
  553  9:00048E  4847          +          SWAP     D7
  554  9:000490  3607                     MOVE.W   D7,D3
  555  9:000492  3E290008                 MOVE.W   ALPHA(A1),D7
  556  9:000496  4EB900000000             JSR      SINE
  557  9:00049C  CFC1                     MULS     D1,D7
  558  9:00049E  E787          +          ASL.L    #16-(SINESS_SCALE-2),D7
  558  9:0004A0  4847          +          SWAP     D7
  559  9:0004A2  3207                     MOVE.W   D7,D1
  560  9:0004A4  3E29000C                 MOVE.W   GAMMA(A1),D7
  561  9:0004A8  4EB900000000             JSR      COSINE
  562  9:0004AE  CFC0                     MULS     D0,D7
  563  9:0004B0  E787          +          ASL.L    #16-(SINESS_SCALE-2),D7
  563  9:0004B2  4847          +          SWAP     D7
  564  9:0004B4  3807                     MOVE.W   D7,D4
  565  9:0004B6  3E29000C                 MOVE.W   GAMMA(A1),D7
  566  9:0004BA  4EB900000000             JSR      SINE
  567  9:0004C0  CFC0                     MULS     D0,D7
  568  9:0004C2  E787          +          ASL.L    #16-(SINESS_SCALE-2),D7
  568  9:0004C4  4847          +          SWAP     D7
  569  9:0004C6  3007                     MOVE.W   D7,D0
  570  9:0004C8  2E3C00000000             MOVE.L   #T_LENGTH,D7
  571  9:0004CE  8EC2                     DIVU     D2,D7
  572  9:0004D0  5247                     ADDQ.W   #SHORT-1,D7
  573  9:0004D2  0247FFFE                 ANDI.W   #-SHORT,D7
  574  9:0004D6  6602                     BNE.S    *+4
  575  9:0004D8  7E02                     MOVEQ.L  #SHORT,D7
  576  9:0004DA  3D47FFFA                 MOVE.W   D7,T_STEP(A6)
  577  9:0004DE  4245                     CLR.W    D5
```


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```
M A K E   N O D E S
9:0004E0  DA6EFFFA              MKND_19 ADD.W   T_STEP(A6),D5
9:0004E4  0C450000              MKND_20 CMPI.W  #T_LENGTH,D5
9:0004E8  6C00FE6A                      BGE     MKND_99
9:0004EC  3E3C07FE                      MOVE.W  #T_LENGTH-SHORT,D7
9:0004F0  9E45                          SUB.W   D5,D7
9:0004F2  41F900000000                  LEA.L   TIME_2_TBL,A0
9:0004F8  3E307000                      MOVE.W  0(A0,D7.W),D7
9:0004FC  CFC0                          MULS    D0,D7
9:0004FE  3C305000                      MOVE.W  0(A0,D5.W),D6
9:000502  CDC1                          MULS    D1,D6
9:000504  9C87                          SUB.L   D7,D6
9:000506  41F900000000                  LEA.L   TIME_1_TBL,A0
9:00050C  3E2EFFFC                      MOVE.W  Y2_Y1(A6),D7
9:000510  CFF05000                      MULS    0(A0,D5.W),D7
9:000514  DC87                          ADD.L   D7,D6
9:000516  E386            +             ASL.L   #16-TIMES8_SCALE,D6
9:000518  4846            +             SWAP    D6
9:00051A  DC51                          ADD.W   (A1),D6
9:00051C  3406                          MOVE.W  D6,D2
9:00051E  9C6D0020                      SUB.W   PLOT_Y(A5),D6
9:000522  6608                          BNE.S   MKND_21
9:000524  066E000AFFFA                  ADD.W   #T_INCREMENT,T_STEP(A6)
9:00052A  60B4                          BRA     MKND_19
9:00052C                        MKND_21 EQU     *
9:00052C  6A02            +             BPL.S   *+4
9:00052E  4446            +             NEG.W   D6
9:000530  0C460003                      CMPI.W  #T_TOOFAR,D6
9:000534  630C                          BLS.S   MKND_22
9:000536  9D6EFFFA                      SUB.W   #T_DECREMENT,T_STEP(A6)
9:00053A  6E06                          BGT.S   MKND_22
9:00053C  3D7C0002FFFA                  MOVE.W  #SHORT,T_STEP(A6)
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```
MAKE  NODES
  614  9:000542  3E3C07FE            MKND_22 MOVE.W  #T_LENGTH-SHORT,D7
  615  9:000546  9E45                        SUB.W   D5,D7
  616  9:000548  41F900000000                LEA.L   TIME_2_TBL,A0
  617  9:00054E  3E307000                    MOVE.W  0(A0,D7.W),D7
  618  9:000552  CFC4                        MULS    D4,D7
  619  9:000554  3C305000                    MOVE.W  0(A0,D5.W),D6
  620  9:000558  CDC3                        MULS    D3,D6
  621  9:00055A  9C87                        SUB.L   D7,D6
  622  9:00055C  41F900000000                LEA.L   TIME_1_TBL,A0
  623  9:000562  3E2EFFFE                    MOVE.W  X2_X1(A6),D7
  624  9:000566  CFF05000                    MULS    0(A0,D5.W),D7
  625  9:00056A  DE86                        ADD.L   D6,D7
  626  9:00056C  E387              +         ASL.L   #16-TIMES_SCALE,D7
  626  9:00056E  4847              +         SWAP    D7
  631  9:000570  DE690002                    ADD.W   MIS_X(A1),D7
  633  9:000574  3C02                        MOVE.W  D2,D6
  634  9:000576  4EB900000000                JSR     NTRPLS
  635  9:00057C  6000FF62                    BRA     MKND_19
  636
  637                                        END
```

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```
andomly Time Tables
ime Function#1
METABL     5    Time Function#1
METABL   137    Time Function#2
                                        +
                                                    xdef    time_1_tbl,time_2_tbl
     C:000000                           +           section 0C                   * Code Section
     C:000000                                   time_1_tbl: equ *                * 3*t*t-2*t*t*t   t=0..1023/1024 by 1/1024
     C:000000   0000000000000001                 dc.w 0,0,0,1,1,2,3,5
     C:000010   000600080009000B                 dc.w 6,8,9,11,13,16,18,21
     C:000020   0018001B001E0021                 dc.w 24,27,30,33,37,41,45,49
     C:000030   0035003A003E0043                 dc.w 53,58,62,67,72,77,83,88
     C:000040   005E0064006A0070                 dc.w 94,100,106,112,119,125,132,139
     C:000050   0092009900A100A8                 dc.w 146,153,161,168,176,184,192,201
     C:000060   00D100DA00E300EC                 dc.w 209,218,227,236,245,254,264,273
     C:000070   011B0125012F013A                 dc.w 283,293,303,314,324,335,346,357
     C:000080   0170017B01870192                 dc.w 368,379,391,402,414,426,438,451
     C:000090   01CF01DC01E901F6                 dc.w 463,476,489,502,515,528,541,555
     C:0000A0   0239024702550263                 dc.w 569,583,597,611,625,640,655,669
     C:0000B0   02AC02BC02CB02DA                 dc.w 684,700,715,730,746,762,778,794
     C:0000C0   032A033A034B035C                 dc.w 810,826,843,860,876,893,911,928
     C:0000D0   03B103C303D503E7                 dc.w 945,963,981,999,1017,1035,1053,1072
     C:0000E0   044204550468047B                 dc.w 1090,1109,1128,1147,1166,1186,1205,1225
     C:0000F0   04DD04F005050519                 dc.w 1245,1264,1285,1305,1325,1346,1366,1387
     C:000100   0580059505AA05C0                 dc.w 1408,1429,1450,1472,1493,1515,1537,1558
     C:000110   062C06430659066F                 dc.w 1580,1603,1625,1647,1670,1693,1716,1739
     C:000120   06E206F907100728                 dc.w 1762,1785,1808,1832,1856,1879,1903,1927
     C:000130   07A007B807D007E9                 dc.w 1952,1976,2000,2025,2050,2075,2100,2125
     C:000140   0866087F089908B3                 dc.w 2150,2175,2201,2227,2252,2278,2304,2330
     C:000150   0935094F096A0984                 dc.w 2357,2383,2410,2436,2463,2490,2517,2544
     C:000160   0A0B0A270A420A5E                 dc.w 2571,2599,2626,2654,2682,2709,2737,2766
     C:000170   0AEA0B060B230B3F                 dc.w 2794,2822,2851,2879,2908,2937,2966,2995
     C:000180   0BD00BED0C0B0C28                 dc.w 3024,3053,3083,3112,3142,3172,3202,3232
     C:000190   0CBE0CDC0CFA0D19                 dc.w 3262,3292,3322,3353,3383,3414,3445,3476
     C:0001A0   0DB30DD20DF10E10                 dc.w 3507,3538,3569,3600,3632,3664,3695,3727
     C:0001B0   0EAF0ECF0EEF0F0F                 dc.w 3759,3791,3823,3855,3888,3920,3953,3985
     C:0001C0   0FB20FD30FF41015                 dc.w 4018,4051,4084,4117,4150,4183,4217,4250
     C:0001D0   10BC10DE10FF1121                 dc.w 4284,4318,4351,4385,4419,4453,4488,4522
     C:0001E0   11CC11EF12111234                 dc.w 4556,4591,4625,4660,4695,4730,4765,4800
     C:0001F0   12E31306132A134D                 dc.w 4835,4870,4906,4941,4977,5012,5048,5084
     C:000200   140014241448146C                 dc.w 5120,5156,5192,5228,5265,5301,5338,5374
     C:000210   15231548156D1592                 dc.w 5411,5448,5485,5522,5559,5596,5633,5670
     C:000220   164C1671169716BD                 dc.w 5708,5745,5783,5821,5858,5896,5934,5972
     C:000230   177A17A017C717ED                 dc.w 6010,6048,6087,6125,6163,6202,6241,6279
     C:000240   18AE18D518FC1923                 dc.w 6318,6357,6396,6435,6474,6513,6552,6592
     C:000250   19E71A0F1A361A5E                 dc.w 6631,6671,6710,6750,6790,6829,6869,6909
     C:000260   1B251B4D1B761B9E                 dc.w 6949,6989,7030,7070,7110,7151,7191,7232
     C:000270   1C681C911CBA1CE3                 dc.w 7272,7313,7354,7395,7436,7477,7518,7559
     C:000280   1DB01DD91E031E2C                 dc.w 7600,7641,7683,7724,7766,7807,7849,7890
     C:000290   1EFC1F261F501F7A                 dc.w 7932,7974,8016,8058,8100,8142,8184,8226
     C:0002A0   204D207720A220CC                 dc.w 8269,8311,8354,8396,8439,8481,8524,8567
     C:0002B0   21A121CC21F72222                 dc.w 8609,8652,8695,8738,8781,8824,8867,8911
     C:0002C0   22FA23252351237C                 dc.w 8954,8997,9041,9084,9128,9171,9215,9259
     C:0002D0   2456248224AE24DA                 dc.w 9302,9346,9390,9434,9478,9522,9566,9610
     C:0002E0   25B625E2260F263B                 dc.w 9654,9698,9743,9787,9831,9876,9920,9965
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adonly Time Tables
me Function #1
C:0002F0  271A2746277327A0    do.w 10010,10054,10099,10144,10188,10233,10278,10323
C:000300  28802BAD28DA2907    do.w 10368,10413,10458,10503,10548,10594,10639,10684
C:000310  29E92A172A442A72    do.w 10729,10775,10820,10866,10911,10957,11002,11048
C:000320  2B562B832BB12BDF    do.w 11094,11139,11185,11231,11277,11323,11369,11415
C:000330  2CC52CF32D212D4F    do.w 11461,11507,11553,11599,11645,11691,11737,11784
C:000340  2E362E642E932EC1    do.w 11830,11876,11923,11969,12016,12062,12108,12155
C:000350  2FAA2FD830073035    do.w 12202,12248,12295,12341,12388,12435,12482,12528
C:000360  311F314E317D31AC    do.w 12575,12622,12669,12716,12763,12810,12857,12904
C:000370  329732C632F53324    do.w 12951,12998,13045,13092,13139,13186,13234,13281
C:000380  3410343F346F349E    do.w 13328,13375,13423,13470,13517,13565,13612,13659
C:000390  358B35BA35EA3619    do.w 13707,13754,13802,13849,13897,13944,13992,14039
C:0003A0  3707373637663796    do.w 14087,14134,14182,14230,14277,14325,14373,14420
C:0003B0  388438B438E33913    do.w 14468,14516,14563,14611,14659,14707,14754,14802
C:0003C0  3A023A323A623A91    do.w 14850,14898,14946,14993,15041,15089,15137,15185
C:0003D0  3B813BB13BE13C11    do.w 15233,15281,15329,15377,15424,15472,15520,15568
C:0003E0  3D003D303D603D90    do.w 15616,15664,15712,15760,15808,15856,15904,15952
C:0003F0  3E803EB03EE03F10    do.w 16000,16048,16096,16144,16192,16240,16288,16336
C:000400  4000403040604090    do.w 16384,16432,16480,16528,16576,16624,16672,16720
C:000410  418041B041E04210    do.w 16768,16816,16864,16912,16960,17008,17056,17104
C:000420  4300433043604390    do.w 17152,17200,17248,17296,17344,17391,17439,17487
C:000430  447F44AF44DF450F    do.w 17535,17583,17631,17679,17727,17775,17822,17870
C:000440  45FE462E465E468D    do.w 17918,17966,18014,18061,18109,18157,18205,18252
C:000450  477C47AC47DB480B    do.w 18300,18348,18395,18443,18491,18538,18586,18634
C:000460  48F949294958498B    do.w 18681,18729,18776,18824,18871,18919,18966,19014
C:000470  4A754AA54AD44B03    do.w 19061,19109,19156,19203,19251,19298,19345,19393
C:000480  4BF04C1F4C4E4C7E    do.w 19440,19487,19534,19582,19629,19676,19723,19770
C:000490  4D694D984DC74DF6    do.w 19817,19864,19911,19958,20005,20052,20099,20146
C:0004A0  4EE14F104F3E4F6D    do.w 20193,20240,20286,20333,20380,20427,20473,20520
C:0004B0  5056508550B450E2    do.w 20566,20613,20660,20706,20752,20799,20845,20892
C:0004C0  51CA51F852275255    do.w 20938,20984,21031,21077,21123,21169,21215,21261
C:0004D0  533B5369539753C5    do.w 21307,21353,21399,21445,21491,21537,21583,21629
C:0004E0  54AA54D855065533    do.w 21674,21720,21766,21811,21857,21902,21948,21993
C:0004F0  561756445671569E    do.w 22039,22084,22129,22174,22220,22265,22310,22355
C:000500  578057AD57DA5807    do.w 22400,22445,22490,22535,22580,22624,22669,22714
C:000510  58E659135940596C    do.w 22758,22803,22848,22892,22937,22981,23025,23070
C:000520  5A4A5A765AA25ACE    do.w 23114,23158,23202,23246,23290,23334,23378,23422
C:000530  5BAA5BD55C015C2D    do.w 23466,23509,23553,23597,23640,23684,23727,23771
C:000540  5D065D315D5D5D88    do.w 23814,23857,23901,23944,23987,24030,24073,24116
C:000550  5E5F5E8A5EB45EDF    do.w 24159,24201,24244,24287,24329,24372,24414,24457
C:000560  5FB35FDE60086032    do.w 24499,24542,24584,24626,24668,24710,24752,24794
C:000570  6104612E61576181    do.w 24836,24878,24919,24961,25002,25044,25085,25127
C:000580  625062796262A2CB    do.w 25168,25209,25250,25291,25332,25373,25414,25455
C:000590  6398630C063E96411   do.w 25496,25536,25577,25617,25658,25698,25738,25779
C:0005A0  64DB65036352B6553   do.w 25819,25859,25899,25939,25978,26018,26058,26097
C:0005B0  66196640666B668F    do.w 26137,26176,26216,26255,26294,26333,26372,26411
C:0005C0  67526779679F67C6    do.w 26450,26489,26527,26566,26605,26643,26681,26720
C:0005D0  68B668AC68D268F8    do.w 26758,26796,26834,26872,26910,26947,26985,27023
C:0005E0  69B469DA69FF6A24    do.w 27060,27098,27135,27172,27209,27246,27283,27320
C:0005F0  6AD96B026B266B4B    do.w 27357,27394,27430,27467,27503,27540,27576,27612
C:000600  6C006C246C486C6C    do.w 27648,27684,27720,27756,27791,27827,27862,27898
C:000610  6D1D6D406D636D86    do.w 27933,27968,28003,28038,28073,28108,28143,28177
C:000620  6E346E566E786E9B    do.w 28212,28246,28280,28315,28349,28383,28417,28450
C:000630  6F446F666F876FA9    do.w 28484,28518,28551,28585,28618,28651,28684,28717
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ly Time Tables

unction #1

```
0640  704E706F708F70B0   do.w 28750,28783,28815,28848,28880,28913,28945,28977
0650  71517171719171B0   do.w 29009,29041,29073,29104,29136,29168,29199,29230
0660  724D726C728B72AA   do.w 29261,29292,29323,29354,29385,29415,29446,29476
0670  73427360737E739C   do.w 29506,29536,29566,29596,29626,29656,29685,29715
0680  7430744D746A7487   do.w 29744,29773,29802,29831,29860,29889,29917,29946
0690  75167532754F756B   do.w 29974,30002,30031,30059,30086,30114,30142,30169
06A0  75F57610762B7646   do.w 30197,30224,30251,30278,30305,30332,30358,30385
06B0  76CB76E67700771A   do.w 30411,30438,30464,30490,30516,30541,30567,30593
06C0  779A77B377CC77E5   do.w 30618,30643,30668,30693,30718,30743,30768,30792
06D0  78607879789178A9   do.w 30816,30841,30865,30889,30912,30936,30960,30983
06E0  791E7935794C7963   do.w 31006,31029,31052,31075,31098,31121,31143,31165
06F0  79D479EA79FF7A15   do.w 31188,31210,31231,31253,31275,31296,31318,31339
0700  7A807A957AAA7ABE   do.w 31360,31381,31402,31422,31443,31463,31483,31504
0710  7B237B377B4B7B5E   do.w 31523,31543,31563,31582,31602,31621,31640,31659
0720  7BBE7BD07BE37BF5   do.w 31678,31696,31715,31733,31751,31769,31787,31805
0730  7C4F7C607C717C83   do.w 31823,31840,31857,31875,31892,31908,31925,31942
0740  7CD67CE67CF67D06   do.w 31958,31974,31990,32006,32022,32038,32053,32068
0750  7D547D637D717D80   do.w 32084,32099,32113,32128,32143,32157,32171,32185
0760  7DC77DD57DE37DF0   do.w 32199,32213,32227,32240,32253,32266,32279,32292
0770  7E317E3D7E4A7E56   do.w 32305,32317,32330,32342,32354,32366,32377,32389
0780  7E907E9B7EA67EB1   do.w 32400,32411,32422,32433,32444,32454,32465,32475
0790  7EE57EEF7EF87F02   do.w 32485,32495,32504,32514,32523,32532,32541,32550
07A0  7F2F7F377F407F48   do.w 32559,32567,32576,32584,32592,32600,32607,32615
07B0  7F6E7F757F7C7F83   do.w 32622,32629,32636,32643,32649,32656,32662,32668
07C0  7FA27FA87FAD7FB3   do.w 32674,32680,32685,32691,32696,32701,32706,32710
07D0  7FCB7FCF7FD37FD7   do.w 32715,32719,32723,32727,32731,32735,32738,32741
07E0  7FE87FEB7FEE7FF0   do.w 32744,32747,32750,32752,32755,32757,32759,32760
07F0  7FFA7FFB7FFD7FFE   do.w 32762,32763,32765,32766,32767,32767,32767,32767
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only Time Tables
  Function #2
:000800                             time_2_tbl: equ *              * t*(t-1)*(t-1) t=0..1023/1024 by 1/1024
:000800  0000002000400005F           do.w 0,32,64,95,127,158,190,221
:000810  00FC011B013A0158            do.w 252,283,314,344,375,406,436,466
:000820  01F0020E022C024A            do.w 496,526,556,586,615,645,674,703
:000830  02DC02F903160333            do.w 732,761,790,819,848,876,905,933
:000840  03C103DD03F90415            do.w 961,989,1017,1045,1072,1100,1127,1155
:000850  049E04B904D404EF            do.w 1182,1209,1236,1263,1290,1316,1343,1369
:000860  0573058E05A805C1            do.w 1395,1422,1448,1473,1499,1525,1551,1576
:000870  0641065B0674068D            do.w 1601,1627,1652,1677,1702,1726,1751,1776
:000880  0708072007390751            do.w 1800,1824,1849,1873,1897,1920,1944,1968
:000890  07C707DF07F6080D            do.w 1991,2015,2038,2061,2084,2107,2130,2153
:0008A0  0880089608AD08C3            do.w 2176,2198,2221,2243,2265,2287,2309,2331
:0008B0  09310946095C0971            do.w 2353,2374,2396,2417,2439,2460,2481,2502
:0008C0  09DB09F00A040A19            do.w 2523,2544,2564,2585,2606,2626,2646,2666
:0008D0  0A7E0A920AA60ABA            do.w 2686,2706,2726,2746,2765,2785,2804,2824
:0008E0  0B1B0B2E0B410B54            do.w 2843,2862,2881,2900,2919,2937,2956,2974
:0008F0  0BB10BC30BD50BE7            do.w 2993,3011,3029,3047,3065,3083,3101,3118
:000900  0C400C510C630C74            do.w 3136,3153,3171,3188,3205,3222,3239,3256
:000910  0CC90CD90CEA0CFA            do.w 3273,3289,3306,3322,3339,3355,3371,3387
:000920  0D4B0D5B0D6B0D7A            do.w 3403,3419,3435,3450,3466,3481,3497,3512
:000930  0DC70DD60DE50DF4            do.w 3527,3542,3557,3572,3587,3602,3616,3631
:000940  0E3D0E4B0E590E68            do.w 3645,3659,3673,3688,3702,3716,3729,3743
:000950  0EAD0EBA0EC80ED5            do.w 3757,3770,3784,3797,3810,3823,3837,3849
:000960  0F160F230F300F3C            do.w 3862,3875,3888,3900,3913,3925,3938,3950
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y  T i m e   T a b l e s
nction #2
70   0F7A0F860F920F9E        do.w 3962,3974,3986,3998,4010,4021,4033,4045
80   0FD80FE30FEF0FFA        do.w 4056,4067,4079,4090,4101,4112,4123,4133
90   1030103B10451050        do.w 4144,4155,4165,4176,4186,4196,4207,4217
A0   1083108D109610A0        do.w 4227,4237,4246,4256,4266,4275,4285,4294
B0   10D010D910E210EB        do.w 4304,4313,4322,4331,4340,4349,4358,4366
C0   1117112011281130        do.w 4375,4384,4392,4400,4409,4417,4425,4433
D0   1159116111691170        do.w 4441,4449,4457,4464,4472,4480,4487,4495
E0   1196119D11A411AB        do.w 4502,4509,4516,4523,4530,4537,4544,4551
F0   11CD11D411DB11E1        do.w 4557,4564,4571,4577,4583,4590,4596,4602
00   12001206120C1212        do.w 4608,4614,4620,4626,4631,4637,4643,4648
10   122E12331238123D        do.w 4654,4659,4664,4669,4674,4679,4684,4689
20   1256125B12601264        do.w 4694,4699,4704,4708,4713,4717,4721,4726
30   127A127E12821286        do.w 4730,4734,4738,4742,4746,4750,4754,4757
40   1299129D12A012A3        do.w 4761,4765,4768,4771,4775,4778,4781,4784
50   12B312B612B912BC        do.w 4787,4790,4793,4796,4799,4802,4804,4807
60   12C912CC12CE12D0        do.w 4809,4812,4814,4816,4819,4821,4823,4825
70   12DB12DD12DF12E0        do.w 4827,4829,4831,4832,4834,4836,4837,4839
80   12E812E912EB12EC        do.w 4840,4841,4843,4844,4845,4846,4847,4848
90   12F112F212F212F3        do.w 4849,4850,4850,4851,4852,4852,4853,4853
A0   12F612F612F612F6        do.w 4854,4854,4854,4854,4854,4855,4855,4854
B0   12F612F612F612F6        do.w 4854,4854,4854,4854,4853,4853,4852,4852
C0   12F312F212F212F1        do.w 4851,4850,4850,4849,4848,4847,4846,4845
D0   12EC12EB12E912E8        do.w 4844,4843,4841,4840,4839,4837,4836,4834
E0   12E112DF12DE12DC        do.w 4833,4831,4830,4828,4826,4824,4822,4820
F0   12D212D012CE12CC        do.w 4818,4816,4814,4812,4810,4807,4805,4802
00   12C012BD12BB12B8        do.w 4800,4797,4795,4792,4790,4787,4784,4781
10   12AA12A712A412A1        do.w 4778,4775,4772,4769,4766,4763,4760,4756
20   1291128E128A1287        do.w 4753,4750,4746,4743,4739,4736,4732,4728
30   12751271126D1269        do.w 4725,4721,4717,4713,4709,4705,4701,4697
40   12551251124D1248        do.w 4693,4689,4685,4680,4676,4672,4667,4663
50   1232122E12291224        do.w 4658,4654,4649,4644,4640,4635,4630,4625
60   120C1207120211FD        do.w 4620,4615,4610,4605,4600,4595,4590,4585
70   11E411DE11D911D4        do.w 4580,4574,4569,4564,4558,4553,4547,4542
80   11B811B211AD11A7        do.w 4536,4530,4525,4519,4513,4507,4501,4496
90   118A1184117E1178        do.w 4490,4484,4478,4472,4465,4459,4453,4447
A0   11591152114C1146        do.w 4441,4434,4428,4422,4415,4409,4402,4396
B0   1125111E11181111        do.w 4389,4382,4376,4369,4362,4356,4349,4342
C0   10EF10E810E110DA        do.w 4335,4328,4321,4314,4307,4300,4293,4286
D0   10B710AF10A810A1        do.w 4279,4271,4264,4257,4250,4242,4235,4227
E0   107C1074106D1065        do.w 4220,4212,4205,4197,4190,4182,4174,4167
F0   103F1037102F1028        do.w 4159,4151,4143,4136,4128,4120,4112,4104
00   10000FF80FF00FE8        do.w 4096,4088,4080,4072,4064,4056,4047,4039
10   0FBF0FB70FAE0FA6        do.w 4031,4023,4014,4006,3998,3989,3981,3973
20   0F7C0F740F6B0F63        do.w 3964,3956,3947,3939,3930,3921,3913,3904
30   0F370F2F0F260F1D        do.w 3895,3887,3878,3869,3860,3852,3843,3834
40   0EF10EE80EDF0ED6        do.w 3825,3816,3807,3798,3789,3780,3771,3762
50   0EA90EA00E970E8E        do.w 3753,3744,3735,3726,3716,3707,3698,3689
60   0E5F0E560E4D0E43        do.w 3679,3670,3661,3651,3642,3633,3623,3614
70   0E140E0B0E010DF8        do.w 3604,3595,3585,3576,3566,3557,3547,3538
80   0DC80DBE0DB50DAB        do.w 3528,3518,3509,3499,3489,3480,3470,3460
90   0D7A0D710D670D5D        do.w 3450,3441,3431,3421,3411,3401,3391,3382
A0   0D2C0D220D180D0E        do.w 3372,3362,3352,3342,3332,3322,3312,3302
B0   0CDC0CD20CC80CBE        do.w 3292,3282,3272,3262,3252,3241,3231,3221
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only Time Tables
 Function #2
C:000CC0   0C8B0C810C770C6C      dc.w 3211,3201,3191,3180,3170,3160,3150,3140
C:000CD0   0C390C2F0C250C1A      dc.w 3129,3119,3109,3098,3088,3078,3068,3057
C:000CE0   0BE70BDD0BD20BC8      dc.w 3047,3037,3026,3016,3005,2995,2985,2974
C:000CF0   0B940B890B7F0B74      dc.w 2964,2953,2943,2932,2922,2911,2901,2890
C:000D00   0B400B350B2B0B20      dc.w 2880,2869,2859,2848,2838,2827,2817,2806
C:000D10   0AEC0AE10AD70ACC      dc.w 2796,2785,2775,2764,2753,2743,2732,2722
C:000D20   0A970A8D0A820A77      dc.w 2711,2701,2690,2679,2669,2658,2647,2637
C:000D30   0A420A380A2D0A22      dc.w 2626,2616,2605,2594,2584,2573,2562,2552
C:000D40   09ED09E209D809CD      dc.w 2541,2530,2520,2509,2498,2488,2477,2466
C:000D50   0998098D09820978      dc.w 2456,2445,2434,2424,2413,2402,2392,2381
C:000D60   09420938092D0922      dc.w 2370,2360,2349,2338,2328,2317,2306,2296
C:000D70   08ED08E208D808CD      dc.w 2285,2274,2264,2253,2243,2232,2221,2211
C:000D80   0898088D08830878      dc.w 2200,2189,2179,2168,2158,2147,2136,2126
C:000D90   08430839082E0823      dc.w 2115,2105,2094,2083,2073,2062,2052,2041
C:000DA0   07EF07E407DA07CF      dc.w 2031,2020,2010,1999,1989,1978,1968,1957
C:000DB0   079B07900786077B      dc.w 1947,1936,1926,1915,1905,1894,1884,1873
C:000DC0   0747073D07320728      dc.w 1863,1853,1842,1832,1821,1811,1801,1790
C:000DD0   06F406EA06DF06D5      dc.w 1780,1770,1759,1749,1739,1729,1718,1708
C:000DE0   06A20698068D0683      dc.w 1698,1688,1677,1667,1657,1647,1637,1627
C:000DF0   06500646063C0632      dc.w 1616,1606,1596,1586,1576,1566,1556,1546
C:000E00   060005F605EC05E2      dc.w 1536,1526,1516,1506,1496,1486,1476,1466
C:000E10   05B105A7059D0593      dc.w 1457,1447,1437,1427,1417,1407,1398,1388
C:000E20   05620558054F0545      dc.w 1378,1368,1359,1349,1339,1330,1320,1311
C:000E30   0515050B050204F8      dc.w 1301,1291,1282,1272,1263,1253,1244,1234
C:000E40   04C904C004B604AD      dc.w 1225,1216,1206,1197,1188,1178,1169,1160
C:000E50   047E0475046C0463      dc.w 1150,1141,1132,1123,1114,1105,1096,1086
C:000E60   0435042C0423041A      dc.w 1077,1068,1059,1050,1041,1032,1024,1015
C:000E70   03EE03E503DC03D3      dc.w 1006,997,988,979,971,962,953,945
C:000E80   03A8039F0397038E      dc.w 936,927,919,910,902,893,885,876
C:000E90   0364035C0353034B      dc.w 868,860,851,843,835,826,818,810
C:000EA0   0322031903110309      dc.w 802,793,785,777,769,761,753,745
C:000EB0   02E102D902D202CA      dc.w 737,729,722,714,706,698,690,683
C:000EC0   02A3029B0294028C      dc.w 675,667,660,652,645,637,630,622
C:000ED0   0267025F02580251      dc.w 615,607,600,593,586,578,571,564
C:000EE0   022D0226021F0218      dc.w 557,550,543,536,529,522,515,508
C:000EF0   01F501EE01E801E1      dc.w 501,494,488,481,474,468,461,455
C:000F00   01C001BA01B301AD      dc.w 448,442,435,429,422,416,410,403
C:000F10   018D01870181017B      dc.w 397,391,385,379,373,367,361,355
C:000F20   015D01570152014C      dc.w 349,343,338,332,326,320,315,309
C:000F30   0130012A0125011F      dc.w 304,298,293,287,282,277,271,266
C:000F40   0105010000FB00F6      dc.w 261,256,251,246,241,236,231,226
C:000F50   00DD00D800D400CF      dc.w 221,216,212,207,202,198,193,189
C:000F60   00B800B400B000AB      dc.w 184,180,176,171,167,163,159,155
C:000F70   00970093008F008B      dc.w 151,147,143,139,135,131,127,124
C:000F80   007800740071006D      dc.w 120,116,113,109,106,103,99,96
C:000F90   005D005900560053      dc.w 93,89,86,83,80,77,74,71
C:000FA0   00450042003F003D      dc.w 69,66,63,61,58,55,53,50
C:000FB0   0030002E002B0029      dc.w 48,46,43,41,39,37,35,33
C:000FC0   001F001D001B001A      dc.w 31,29,27,26,24,22,21,19
C:000FD0   00120010000F000D      dc.w 18,16,15,13,12,11,10,9
C:000FE0   0008000700060005      dc.w 8,7,6,5,4,4,3,3
C:000FF0   0002000200010001      dc.w 2,2,1,1,0,0,0,0

             end
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Module -IV-

L I N E A R - I N T E R P O L A T O R / EXTENDED PRECISION

```
NTRPLS   IDNT     1,0 CURVE FONT LINEAR INTERPOLLATOR
         XDEF     NTRPLS
         XREF     PLOT_INSERT
         XREF     VEKTOR,GERADE            * TO SHOW BUILDING OF CHAR
INSERT   MACRO          INSERT D1
         IFNC     '\1',''
         MOVE.W   \1,D1
         ENDC
         ADD.W    D1,D1
         TST.B    COLOR(A5)
         BEQ.S    *+4
         ADDQ.W   #1,D1
         JSR      PLOT_INSERT
         ENDM
```

lodule -IV-

```
.I N E A R - I N T E R P O L A T O R / EXTENDED PRECISION
 20  9:000000                    +           SECTION  09        * CODE SECTION
 21  9:000000  48A7CC00              NTRPLB  MOVEM.W  D0/D1/D4/D5,-(SP)
 22  9:000004  3A07                          MOVE.W   D7,D5
 23  9:000006  3806                          MOVE.W   D6,D4
 24  9:000008  4A383001                      TST.B    1
 25  9:00000C  673C                          BEQ.S    NTRP1A
 26  9:00000E  48E7FFFE                      MOVEM.L  D0-D7/A0-A6,-(SP)
 27  9:000012  41F900000000                  LEA.L    GERADE,A0
 28  9:000018  3F2D0020                      MOVE.W   OLD_RASTER(A5),D7
 29  9:00001C  4447                          NEG.W    D7
 30  9:00001E  DE6D0024                      ADD.W    LN_EM_Y(A5),D7
 31  9:000022  30C7                          MOVE.W   D7,(A0)+
 32  9:000024  3E2D0022                      MOVE.W   OLD_INTERCEPT(A5),D7
 33  9:000028  DE6D0026                      ADD.W    LN_EM_X(A5),D7
 34  9:00002C  30C7                          MOVE.W   D7,(A0)+
 35  9:00002E  3E04                          MOVE.W   D4,D7
 36  9:000030  4447                          NEG.W    D7
 37  9:000032  DE6D0024                      ADD.W    LN_EM_Y(A5),D7
 38  9:000036  30C7                          MOVE.W   D7,(A0)+
 39  9:000038  3E05                          MOVE.W   D5,D7
 40  9:00003A  DE6D0026                      ADD.W    LN_EM_X(A5),D7
 41  9:00003E  3087                          MOVE.W   D7,(A0)
 42  9:000040  4EB900000000                  JSR      VEKTOR
 43  9:000046  4CDF7FFF                      MOVEM.L  (SP)+,D0-D7/A0-A6
 44  9:00004A  302D0020              NTRP1A  MOVE.W   OLD_RASTER(A5),D0
 45  9:00004E  9840                          SUB.W    D0,D4
 46  9:000050  6646                          BNE.S    NTRP_4
 47  9:000052  BA6D0022                      CMP.W    OLD_INTERCEPT(A5),D5
 48  9:000056  673A                          BEQ.S    NTRP_0
 49  9:000058  5EC7                          SGT      D7
 50  9:00005A  BE2D002F                      CMP.B    INIT_COLOR(A5),D7
 51  9:00005E  56C7                          SNE      D7
 52  9:000060  BE2D002E                      CMP.B    COLOR(A5),D7
 53  9:000064  6728                          BEQ.S    NTRP_3
 54  9:000066  1807                          MOVE.B   D7,D4
 55  9:000068  322D0022                      MOVE.W   OLD_INTERCEPT(A5),D1
 56  9:00006C  D241                  +       ADD.W    D1,D1
 56  9:00006E  4A2D002E              +       TST.B    COLOR(A5)
 56  9:000072  6702                  +       BEQ.S    *+4
 56  9:000074  5241                  +       ADDQ.W   #1,D1
 56  9:000076  4EB900000000          +       JSR      PLOT_INSERT
 57  9:00007C  1B44002E                      MOVE.B   D4,COLOR(A5)
 58  9:000080  600C                          BRA.S    NTRP_3
 59  9:000082  3E1F                  NTRP_1  MOVE.W   (SP)+,D7
 60  9:000084  4CDF000C                      MOVEM.L  (SP)+,D2/D3
 61  9:000088  D047                  NTRP_2  ADD.W    D7,D0
 62  9:00008A  3B400020                      MOVE.W   D0,OLD_RASTER(A5)
 63  9:00008E  3B450022              NTRP_3  MOVE.W   D5,OLD_INTERCEPT(A5)
 64  9:000092  4C9F0033              NTRP_0  MOVEM.W  (SP)+,D0/D1/D4/D5
 65  9:000096  4E75                          RTS
```

Module -IV-

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LINEAR-INTERPOLATOR / EXTENDED PRECISION

```
 67  9:00009B  5EC7                      NTRP_4   SGT      D7
 68  9:00009A  BE2D002E                           CMP.B    COLOR(A5),D7
 69  9:00009E  6714                               BEQ.S    NTRP_5
 70  9:0000A0  322D0022          +                MOVE.W   OLD_INTERCEPT(A5),D1
 70  9:0000A4  D241              +                ADD.W    D1,D1
 70  9:0000A6  4A2D002E          +                TST.B    COLOR(A5)
 70  9:0000AA  6702              +                BEQ.S    *+4
 70  9:0000AC  5241              +                ADDQ.W   #1,D1
 70  9:0000AE  4EB900000000      +                JSR      PLOT_INSERT
 71  9:0000B4  7E01                      NTRP_5   MOVEQ.L  #1,D7
 72  9:0000B6  3C04                               MOVE.W   D4,D6
 73  9:0000B8  5DED002E                           SLT      COLOR(A5)
 74  9:0000BC  6C04                               BGE.S    NTRP_6
 75  9:0000BE  4446                               NEG.W    D6
 76  9:0000C0  7EFF                               MOVEQ.L  #-1,D7
 77  9:0000C2  0C460001                  NTRP_6   CMP.W    #1,D6
 78  9:0000C6  67C0                               BEQ      NTRP_2
 79  9:0000C8  48E73000                           MOVEM.L  D2/D3,-(SP)
 80  9:0000CC  3F07                               MOVE.W   D7,-(SP)
 81  9:0000CE  3405                               MOVE.W   D5,D2
 82  9:0000D0  946D0022                           SUB.W    OLD_INTERCEPT(A5),D2
 83  9:0000D4  48C2                               EXT.L    D2
 84  9:0000D6  3202                               MOVE.W   D2,D1
 85  9:0000D8  6A02              +                BPL.S    *+4
 85  9:0000DA  4441              +                NEG.W    D1
 86  9:0000DC  7E04                               MOVEQ.L  #4,D7
 87  9:0000DE  760D                               MOVEQ.L  #12+1,D3
 88  9:0000E0  5343                      NTRP_7   SUBQ.W   #1,D3
 89  9:0000E2  6706                               BEQ.S    NTRP_8
 90  9:0000E4  DE47                               ADD.W    D7,D7
 91  9:0000E6  BE41                               CMP.W    D1,D7
 92  9:0000E8  63F6                               BLS      NTRP_7
 93  9:0000EA  0C460002                  NTRP_8   CMP.W    #2,D6
 94  9:0000EE  671E                               BEQ.S    NTRP_11
 95  9:0000F0  0C460004                           CMP.W    #4,D6
 96  9:0000F4  6718                               BEQ.S    NTRP_11
 97  9:0000F6  7E02                               MOVEQ.L  #2,D7
 98  9:0000F8  5243                      NTRP_9   ADDQ.W   #1,D3
 99  9:0000FA  0C43000F                           CMP.W    #15,D3
100  9:0000FE  6C06                               BGE.S    NTRP_10
101  9:000100  DE47                               ADD.W    D7,D7
102  9:000102  BE46                               CMP.W    D6,D7
103  9:000104  63F2                               BLS      NTRP_9
104  9:000106  E7A2                      NTRP_10  ASL.L    D3,D2
105  9:000108  85C6                               DIVS     D6,D2
106  9:00010A  48C2                               EXT.L    D2
107  9:00010C  6006                               BRA.S    NTRP_12
```

```
L I N E A R - I N T E R P O L A T O R / EXTENDED PRECISION
 109  9:00010E  E7A2                   NTRP_11 ASL.L   D3,D2
 110  9:000110  E246                           ASR.W   #1,D6
 111  9:000112  D646                           ADD.W   D6,D3
 112  9:000114  3C2D0022               NTRP_12 MOVE.W  OLD_INTERCEPT(A5),D6
 113  9:000118  48C6                           EXT.L   D6
 114  9:00011A  E7A6                           ASL.L   D3,D6
 115  9:00011C  9857                   NTRP_13 SUB.W   (SP),D4
 116  9:00011E  6700FF62                       BEQ     NTRP_1
 117  9:000122  D057                           ADD.W   (SP),D0
 118  9:000124  DC82                           ADD.L   D2,D6
 119  9:000126  2E06                           MOVE.L  D6,D7
 120  9:000128  E6A7                           ASR.L   D3,D7
 121  9:00012A  3207                 +         MOVE.W  D7,D1
 121  9:00012C  D241                 +         ADD.W   D1,D1
 121  9:00012E  4A2D002E             +         TST.B   COLOR(A5)
 121  9:000132  6702                 +         BEQ.S   *+4
 121  9:000134  5241                 +         ADDQ.W  #1,D1
 121  9:000136  4EB900000000         +         JSR     PLOT_INSERT
 122  9:00013C  60DE                           BRA     NTRP_13
 123
 124                                           END
```

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PLOTQUEUE INSERT, OUTPUT, CLEAR, & CHECK

```
                  PLOTQ    IDNT     1,0 CURVE FONT RASTER SORTING SYSTEM
                           INCLUDE RCHPAR
                  *   STRUKTUR DES PASCAL-PARAMETERBLOCKS
                  *   -----------------------------------
                  *
00000000                   OFFSET     0
00000000          RCHPAR   EQU        *
00000000          CHARJOB  DS.W       1              AUFTRAGSART: 0=SYSTEM-INIT,1=JOB-INIT
                  *                                                2=ZEICHEN-INIT
00000002          JOBPARBL EQU        *                     JOB-PARAMETER
00000002          AUFLX    DS.W       1
00000004          AUFLY    DS.W       1
00000006          ZOOMP    DS.W       1
                  *
00000008          ZEITAB   EQU       *                      ZEICHEN-PARAMETER
00000008          C2       DS.W      1
0000000A          FONADR   DS.L      1
0000000E          MCBADR   DS.L      1                      POINTER AUF MCB
00000012          ERRORNR  DS.W      1                      SYSTEM-ERRORNUMMER
                  *
                  *
                  *
                  *  DATENTYPEN FUER MEMO-CONTROL-BLOCK
                  *  ----------------------------------
00000000                   OFFSET     0
                  *
00000000          MCKENN   EQU        *
00000000          V90C     DS.B       1
00000001          EQUCHK   DS.B       1          FUER SCAN
00000002          CFKENN   DS.W       1          FONTLOC/FORM-KENNUNG
00000004          FONTNR   DS.W       1          FONTNR/LAUFENDE FORM-NR
00000006          SC       DS.W       1          SCHRIFTGRAD
00000008          CE       DS.W       1          CONDENSED-EXPAND
                  * HIER MUESSEN DANN SLANT_WIN,ROT_WIN REIN
                  *
0000000A          OPCL     DS.W       1
0000000C          CHAR_OFF DS.W       1          ABSTAND IN MI'S REL-YNULL->ZEICHENOBERKANTE
0000000E          BASE_OFF DS.W       1/           "      "     ZEICHENOBERKANTE->SCHRIFTLINIE
00000010          SCANCT   DS.L       1            "      "          "          -> -UNTERKANTE
00000014          IPADR    DS.L       1          POINTER AUF MEMEO-SEGMENT
00000018          SEG_LAEN DS.W       1          MEMOSEGMENT-LAENGE IN WORTEN
0000001A          MEM_LAEN DS.L       1

                  *        ERROR NUMBERS
0000001E          BUFOVER  SET        30
00000011          FONTERR  SET        17
0000004B          PARERR   SET        75
```

PLOTQUEUE INSERT, OUTPUT, CLEAR, & CHECK

```
   9                                    +
  10  00008000                                END_RASTER      EQU     $8000
  11  00000000                                MEMO_II SET     FALSE
  13  0000DFFF                                BLANK_RASTER    EQU     $DFFF
  14  0000DFFE                                END_MEMO        EQU     $DFFE
  19
  20  00000000                          +     PQSV_LINE:        SET   0                 LINE NUMBER OF SEGMENT
  20  00000008                          +     PQSS_LINE:        SET   8
  20  000000FF                          +     PQSM_LINE:        SET (1<<8-1)<<0
  21  00000008                          +     PQSV_SGMNT:       SET   PQSS_LINE                  SEGMENT NUMBER FROM RASTER
  21  00000008                          +     PQSS_SGMNT:       SET   (16-PQSS_LINE)
  21  0000FF00                          +     PQSM_SGMNT:       SET (1<<((16-PQSS_LINE)-1)<<PQSS_LINE
  22
  23  00000000                          +     PQLSV_ENTRIES:    SET   0                 * MASK  FOR NUMBER OF LINE ENTRIES
  23  00000003                          +     PQLSS_ENTRIES:    SET   3
  23  00000007                          +     PQLSM_ENTRIES:    SET (1<<3-1)<<0
  24  00000006                                PQLSK_ENTRIES   SET     6
  25  7:000000                          +             SECTION 07            * DATA SECTION
  26  00000100                                PQQSK_ENTRIES   SET     1<<PQSS_SGMNT
  27  7:000000   0000000000000000             PQQSL_SEGMENT   DCB.L   PQQSK_ENTRIES,0
  28  7:000400                                PDON_SP         DS.L    1
  29  7:000404                                MEMO_LENGTH     DS.L    1
  30
  31  00000000                                        OFFSET  0
  32  00000100                                PQSSK_ENTRIES   SET     1<<PQSS_LINE
  33  00000000   0000000000000000             PQSSB_COUNT     DCB.B   PQSSK_ENTRIES,0
  34  00000100   0000000000000000             PQSSL_LINE      DCB.L   PQSSK_ENTRIES,0
  35  00000500                                PQSSK_LENGTH    SET     *
  36
  37  00000000                                        OFFSET  0
  38  00000000   00000001                     PQLSL_PTR       DC.L    1
  39  00000004   0000000000000000             PQLSW_VALUES    DCB.W   PQLSK_ENTRIES,0
  40  00000010                                PQLSK_LENGTH    SET     *
```

Module -V-

D E F I N I T I O N S

```
*       MACROS TO HANDLE SEGMENT TABLES
*
THIS_SEGMENT    MACRO
        MOVE.W  D0,D7
        LSR.W   #PQSV_SGMNT,D7
        INDEX.W LONG,D7
        LEA.L   PQSOL_SEGMENT,A0
        LEA.L   0(A0,D7.W),A2
        MOVE.L  (A2),D7
        ENDM

THIS_LINE       MACRO           THIS_LINE REG_STORE
        MOVE.W  D0,D7
        ANDI.W  #PQSM_LINE,D7
        INDEX.W LONG,D7
        IFEQ    PQSOL_LINE$0FFFFFF00
        LEA.L   PQSOL_LINE(A2,D7.W),A0
        MOVE.L  (A0),\1
        MEXIT
        ENDC
        LEA.L   PQSOL_LINE(A2),A0
        LEA.L   0(A0,D7.W),A0
        MOVE.L  (A0),\1
        ENDM
```

MACROS

```
THIS_COUNT      MACRO                   THIS_COUNT REGISTER(OPTIONAL)
        MOVE.W  D0,D7
        ANDI.W  #PQSM_LINE,D7
        INDEX.W BYTE,D7
          IFEQ  PQS0B_COUNT80FFFFFF80
        LEA.L   PQS0B_COUNT(A2,D7.W),A0
          ENDC
          IFNE  PQS0B_COUNT80FFFFFF80
        LEA.L   PQS0B_COUNT(A2),A0
        LEA.L   0(A0,D7.W),A0
          ENDC
          IFNC  '\1',''
        MOVE.B  (A0),\1
          ENDC
        ENDM

INTO_MEMO       MACRO                   INTO_MEMO VALUE
        ADDQ.L  #1,D5
        SUBQ.L  #SHORT,D6
        IFC     '\0','S'
        BGE.S   *+4
        ENDC
        IFNC    '\0','S'
        BGE.S   *+6
        ENDC
        BSR.\0  MORE_MEMO
        MOVE.W  \1,(A4)+
        ENDM
```

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C R O S

```
                          INCLUDE STORMAC
                  *       M A C R O   F O R   M E M O R Y   A L L O C A T I O N
                  *
00000001          ONLY1AREA: SET TRUE                         * IF ONLY 1 AREA

                          XREF     AALLOC
                          XREF     AFREE

                  GETMAIN: MACRO :                  GETMAIN.QUAL SIZE,<COMMENT>
                          MAINSIZE.\0 \1,<** \2>
                          JSR      AALLOC                     * *GET A BLOCK FROM THE POOL
                          ENDM

                  FREEMAIN: MACRO:                  FREEMAIN.QUAL SIZE,PTR,<COMMENT>
                          IFC      '\2','A0'
                  * ADDRESS TO FREE IN LONGWORD A0
                          ENDC
                          IFNC     '\2','A0'
                            IFC    '\2','D7'
                          MOVE.L   D7,A0                      ** \3
                            ENDC
                            IFNC   '\2','D7'
                          LEA.L    (\2),A0                    ** \3
                            ENDC
                          ENDC
                          MAINSIZE.\0 \1,<* *>
                          JSR      AFREE                      ** RETURN BLOCK TO POOL
                          ENDM

                  *       .L= LONG REFERENCE        .W= SHORT REFERENCE
                  *       .S= SHORT VALUE IN D7     .= BY VALUE
                  MAINSIZE:        MACRO                      MAINSIZE.QUAL SIZE,<COMMENT>
                          IFC      '\0','S'
                          EXT.L    D7              \2
                          MEXIT
                          ENDC
                          IFC      '\1',''
                  * MEMORY REQUEST LENGTH GIVEN IN LONGWORD D7
                          MEXIT
                          ENDC
                          IFC      '\0',''
                          MOVE.L   #\1,D7  \2
                          MEXIT
                          ENDC
                          IFC      '\0','L'
                          MOVE.L   \1,D7           \2
                          MEXIT
                          ENDC
                          MOVEQ.L  #0,D7
                          MOVE.W   \1,D7           \2
                          ENDM
```

```
LOT  CHECK
 99                                        *       P L O T _ C H E C K
100                                        *
101                                                XDEF     PLOT_CHECK
102  9:000000                         +            SECTION  09              * CODE SECTION
103  9:000000                              PLOT_CHECK EQU   *
104  9:000000  4852                                PEA      (A2)
105  9:000002  3E00                       +        MOVE.W   D0,D7
105  9:000004  E04F                       +        LSR.W    #PQSV_SGMNT,D7
105  9:000006  E54F                       +        LSL.W    #2,D7
105  9:000008  41F900000000               +        LEA.L    PQQSL_SEGMENT,A0
105  9:00000E  45F07000                   +        LEA.L    0(A0,D7.W),A2
105  9:000012  2E12                       +        MOVE.L   (A2),D7
106  9:000014  6714                                BEQ.S    PCHK_1
107  9:000016  2447                                MOVE.L   D7,A2
108  9:000018  3E00                       +        MOVE.W   D0,D7
108  9:00001A  024700FF                   +        ANDI.W   #PQSM_LINE,D7
108                                       +  * D7 ALREADY INDEX TO CHAR
108  9:00001E  41F27000                   +        LEA.L    PQSSR_COUNT(A2,D7.W),A0
109  9:000022  08100000                            BTST     #0,(A0)
110  9:000026  6702                                BEQ.S    PCHK_1
111  9:000028  6104                                BSR.S    PLOT_INSERT
112  9:00002A  245F                        PCHK_1  MOVE.L   (SP)+,A2
113  9:00002C  4E75                                RTS
```



```
I N S E R T
                                 *         P L O T _ I N S E R T
                                 *
                                           XDEF      PLOT_INSERT
000002E                   +                SECTION 09           * CODE SECTION
000002E                          PLOT_INSERT EQU *
000002E  48E70030                          MOVEM.L A3/A2,-(SP)
0000032  48A73000                          MOVEM.W D2/D3,-(SP)
0000036  41ED001A                          LEA.L    MIN_INTERCEPT(A5),A0
000003A  B250                              CMP.W    (A0),D1
000003C  6C02                              BGE.S    PINS_1
000003E  3081                              MOVE.W   D1,(A0)
0000040                          PINS_1    EQU      *
0000040  5888             +                ADDQ.L   #MAX_INTERCEPT-MIN_INTERCEPT,A0
0000042  B250                              CMP.W    (A0),D1
0000044  6F02                              BLE.S    PINS_2
0000046  3081                              MOVE.W   D1,(A0)
0000048                          PINS_2    EQU      *
0000048  5D88             +                SUBQ.L   #-(MIN_RASTER-MAX_INTERCEPT),A0
000004A  B050                              CMP.W    (A0),D0
000004C  6C02                              BGE.S    PINS_3
000004E  3080                              MOVE.W   D0,(A0)
0000050                          PINS_3    EQU      *
0000050  5888             +                ADDQ.L   #MAX_RASTER-MIN_RASTER,A0
0000052  B050                              CMP.W    (A0),D0
0000054  6F02                              BLE.S    PINS_4
0000056  3080                              MOVE.W   D0,(A0)
0000058                          PINS_4    EQU      *
0000058  3E00             +                MOVE.W   D0,D7
000005A  E04F             +                LSR.W    #PQSV_SGMNT,D7
000005C  E54F             +                LSL.W    #2,D7
000005E  41F900000000     +                LEA.L    PQQSL_SEGMENT,A0
0000064  45F07000         +                LEA.L    0(A0,D7.W),A2
0000068  2E12             +                MOVE.L   (A2),D7
000006A  661A                              BNE.S    PINS_6
000006C  2E3C00000500     +                MOVE.L   #PQSSK_LENGTH,D7       **
0000072  4EB900000000     +                JSR      AALLOC                 * *GET A BLOCK FROM THE POOL
0000078  2487                              MOVE.L   D7,(A2)
000007A  2047                              MOVE.L   D7,A0
000007C  343C0500                          MOVE.W   #PQSSK_LENGTH,D2
0000080  4298                              CLR.L    (A0)+
0000082  5942                              SUBQ.W   #LONG,D2
0000084  66FA                              BNE      *-4
```



```
N S E R T
0086  2447                PINS_6  MOVE.L  D7,A2
0088  3E00           +            MOVE.W  D0,D7
008A  024700FF       +            ANDI.W  #PQS0M_LINE,D7
                     +    * D7 ALREADY INDEX TO CHAR
008E  41F27000       +            LEA.L   PQS0B_COUNT(A2,D7.W),A0
0092  1410           +            MOVE.B  (A0),D2
0094  4850                        PEA     (A0)
0096  3E00           +            MOVE.W  D0,D7
0098  024700FF       +            ANDI.W  #PQS0M_LINE,D7
009C  E54F           +            LSL.W   #2,D7
009E  41EA0100       +            LEA.L   PQS0L_LINE(A2),A0
00A2  41F07000       +            LEA.L   0(A0,D7.W),A0
00A6  2650           +            MOVE.L  (A0),A3
00A8  3602                        MOVE.W  D2,D3
00AA  02430007                    ANDI.W  #PQL0M_ENTRIES,D3
00AE  670E                        BEQ.S   PINS_7
00B0  D643           +            ADD.W   D3,D3
00B2  41F33004                    LEA.L   PQL0W_VALUES(A3,D3.W),A0
00B6  08030001                    BTST    #1,D3
00BA  671A                        BEQ.S   PINS_8
00BC  6020                        BRA.S   PINS_9

00BE  2448                PINS_7  MOVE.L  A0,A2
00C0  7E10           +            MOVE.L  #PQL0K_LENGTH,D7        ** ALLOCATE NEW LINE
00C2  4EB900000000   +            JSR     AALLOC                  * GET A BLOCK FROM THE POOL
00C8  CF8B                        EXG     D7,A3
00CA  2687                        MOVE.L  D7,(A3)
00CC  248B                        MOVE.L  A3,(A2)
00CE  343C000E                    MOVE.W  #1<<(PQL0G_ENTRIES+PQL0K_ENTRIES,D2
00D2  41EB0010                    LEA.L   PQL0K_ENTRIES*SHORT+PQL0W_VALUES(A3),A0
00D6  3E01                PINS_8  MOVE.W  D1,D7
00D8  5247                        ADDQ.W  #1,D7
00DA  3147FFFC                    MOVE.W  D7,-2*SHORT(A0)
00DE  3101                PINS_9  MOVE.W  D1,-(A0)
00E0  205F                        MOVE.L  (SP)+,A0
00E2  5302                        SUBQ.B  #1,D2
00E4  1082                        MOVE.B  D2,(A0)
00E6  4C9F000C                    MOVEM.W (SP)+,D2/D3
00EA  4CDF0C00                    MOVEM.L (SP)+,A3/A2
00EE  4E75                        RTS
```

odule -V-

PLOT DONE

```
                                  *       P L O T _ D O N E
                                  *
                                          XDEF     PLOT_DONE
                                          XREF     MEWA,M_NEXT,M_KILL,PCHPAR,PASCAL_REGISTERS
9:0000F0                      +           SECTION  09               * CODE SECTION
9:0000F0                          PLOT_DONE EQU    *
9:0000F0  48E7067A                        MOVEM.L  D5/D6/A6/A2/A3/A4/A1,-(SP)
9:0000F4  48A7F800                        MOVEM.W  D2/D3/D1/D0/D4,-(SP)
9:0000F8  23CF00000400                    MOVE.L   SP,PDON_SP
9:0000FE  4A2D002D                        TST.B    LOOP_NOT_CLOSED(A5)
9:000102  660001FA                        BNE      PDON_30
9:000106  4285                            CLR.L    D5
9:000108  9DCE                            SUB.L    A6,A6
9:00010A  287900000000                    MOVE.L   PCHPAR,A4
9:000110  286C000E                        MOVE.L   MCBADR(A4),A4
9:000114  4286                            CLR.L    D6
9:000116  3C2C0018                        MOVE.W   SEG_LAEN(A4),D6
9:00011A  5386                            SUBQ.L   #1,D6
9:00011C  DC86                +           ADD.L    D6,D6
9:00011E  23C600000404                    MOVE.L   D6,MEMO_LENGTH
9:000124  286C0014                        MOVE.L   IPADR(A4),A4
9:000128  302D001C                        MOVE.W   MAX_RASTER(A5),D0
9:00012C  3800                            MOVE.W   D0,D4
9:00012E  5249                            ADDQ.W   #1,D0
9:000130  5349                    PDON_1  SUBQ.W   #1,D0
9:000132  B06D0018                        CMP.W    MIN_RASTER(A5),D0
9:000136  6D1A                            BLT.S    PDON_2
9:000138  3E00                +           MOVE.W   D0,D7
9:00013A  E04F                +           LSR.W    #PQ0V_SCHNT,D7
9:00013C  E54F                +           LSL.W    #2,D7
9:00013E  41F900000000        +           LEA.L    PQ0SL_SEGMENT,A0
9:000144  45F07000            +           LEA.L    0(A0,D7.W),A2
9:000148  2E12                +           MOVE.L   (A2),D7
9:00014A  666C                            BNE.S    PDON_5
9:00014C  0240FF00                        ANDI.W   #PQ0M_SCHNT,D0
9:000150  60DE                            BRA      PDON_1
```

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```
'LOT  DONE
 220                                          ***STO-A
 221                                          ***PDON_2  MOVE.W  D4,MIN_RASTER(A5)
 222   9:000152                               PDON_2   EQU      *
 223                                          ***STO-E
 225   9:000152  5486                                  ADDQ.L   #SHORT,D6
 226   9:000154  5285              +                   ADDQ.L   #1,D5
 226   9:000156  5586              +                   SUBQ.L   #SHORT,D6
 226   9:000158  6C04              +                   BCE.S    *+6
 226   9:00015A  61000168          +                   BSR.L    MORE_MEMO
 226   9:00015E  38FCDFFE          +                   MOVE.W   #END_MEMO,(A4)+
 232   9:000162  610001E4                              BSR      RELEASE_QUEUE
 233                                          ***STO-A
 234   9:000166  3B44001B                              MOVE.W   D4,MIN_RASTER(A5)
 235                                          ***STO-E
 236   9:00016A  E0ED001A                              ASR.W    MIN_INTERCEPT(A5)
 237   9:00016E  6404                                  BCC.S    PDON_3
 238   9:000170  536D001E                              SUBQ.W   #1,MAX_INTERCEPT(A5)
 239   9:000174  E0ED001E                     PDON_3   ASR.W    MAX_INTERCEPT(A5)
 240   9:000178  207900000000                          MOVE.L   PCHPAR,A0
 241   9:00017E  2068000E                              MOVE.L   MCBADR(A0),A0
 242   9:000182  2145001A                              MOVE.L   D5,MEM_LAEN(A0)
 243   9:000186  3E2D0024                              MOVE.W   LN_EM_Y(A5),D7
 244   9:00018A  9E6D001C                              SUB.W    MAX_RASTER(A5),D7
 245   9:00018E  3147000C                              MOVE.W   D7,CHAR_OFF(A0)
 246   9:000192  3E2D001C                              MOVE.W   MAX_RASTER(A5),D7
 247   9:000196  3147000E                              MOVE.W   D7,BASE_OFF(A0)
 248   9:00019A  3C2D001B                              MOVE.W   MIN_RASTER(A5),D6
 249   9:00019E  48C7                                  EXT.L    D7
 250   9:0001A0  48C6                                  EXT.L    D6
 251   9:0001A2  9E86                                  SUB.L    D6,D7
 252   9:0001A4  21470010                              MOVE.L   D7,SCANCT(A0)
 253   9:0001A8  2E7900000400                 PDON_4   MOVE.L   PDON_SP,SP
 254   9:0001AE  4C9F001F                              MOVEM.W  (SP)+,D2/D3/D1/D0/D4
 255   9:0001B2  4CDF5E60                              MOVEM.L  (SP)+,D5/D6/A6/A2/A3/A4/A1
 256   9:0001B6  4E75                                  RTS
```

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```
P L O T   D O N E
  258  9:0001B8  2447                 PDON_5  MOVE.L  D7,A2
  259  9:0001BA  3E00           +             MOVE.W  D0,D7
  259  9:0001BC  024700FF       +             ANDI.W  #PQSM_LINE,D7
  259                           +     * D7 ALREADY INDEX TO CHAR
  259  9:0001C0  41F27000       +             LEA.L   PQS0B_COUNT(A2,D7.W),A0
  259  9:0001C4  1410           +             MOVE.B  (A0),D2
  260  9:0001C6  6700FF68                     BEQ     PDON_1
  261  9:0001CA  3E00           +             MOVE.W  D0,D7
  261  9:0001CC  024700FF       +             ANDI.W  #PQSM_LINE,D7
  261  9:0001D0  E34F           +             LSL.W   #2,D7
  261  9:0001D2  41EA0100       +             LEA.L   PQS0L_LINE(A2),A0
  261  9:0001D6  41F07000       +             LEA.L   0(A0,D7.W),A0
  261  9:0001DA  2650           +             MOVE.L  (A0),A3
  262                                 ***STO-A
  263  9:0001DC  4290                         CLR.L   (A0)
  264                                 ***STO-E
  265  9:0001DE  4243                         CLR.W   D3
  266  9:0001E0  02420006                     ANDI.W  #PQLSM_ENTRIES8-2,D2
  267  9:0001E4  D442           +             ADD.W   D2,D2
  268  9:0001E6  45F32004                     LEA.L   PQL0W_VALUES(A3,D2.W),A2
  269  9:0001EA  0442000C                     SUBI.W  #PQLSK_ENTRIES*SHORT,D2
  270  9:0001EE  9642                         SUB.W   D2,D3
  271  9:0001F0  2F1A                         MOVE.L  (A2)+,-(SP)
  272  9:0001F2  5842                         ADDQ.W  #LONG,D2
  273  9:0001F4  66FA                         BNE.S   *-4
  274  9:0001F6                       PDON_6  EQU     *
  276  9:0001F6  2453                         MOVE.L  (A3),A2
  281  9:0001F8  41D3           +             LEA.L   (A3),A0                  **
  281  9:0001FA  7E10           +             MOVE.L  #PQLSK_LENGTH,D7         * *
  281  9:0001FC  4EB900000000   +             JSR     AFREE                    ** RETURN BLOCK TO POOL
  282  9:000202  2E0A                         MOVE.L  A2,D7
  283  9:000204  6712                         BEQ.S   PDON_7
  284  9:000206  2647                         MOVE.L  D7,A3
  285  9:000208  45ED0004                     LEA.L   PQL0W_VALUES(A3),A2
  286  9:00020C  0643000C                     ADDI.W  #PQLSK_ENTRIES*SHORT,D6
  294  9:000210  2F1A                         MOVE.L  (A2)+,-(SP)
  295  9:000212  2F1A                         MOVE.L  (A2)+,-(SP)
  298  9:000214  2F1A                         MOVE.L  (A2)+,-(SP)
  300  9:000216  60DE                         BRA     PDON_6
  301  9:000218  224F                 PDON_7  MOVE.L  SP,A1
  302  9:00021A  3E03                         MOVE.W  D3,D7
  303  9:00021C  5547                         SUBQ.W  #SHORT,D7
  304  9:00021E  3F07                         MOVE.W  D7,-(SP)
  305  9:000220  4267                         CLR.W   -(SP)
  306  9:000222  610001BE                     BSR     QUICK_SORT
  307  9:000226  508F           +             ADDQ.L  #2*SHORT,SP
  308  9:000228  322D001A                     MOVE.W  MIN_INTERCEPT(A5),D1
  310  9:00022C  02410001                     AND.W   #1,D1
  312  9:000230                       PDON_8  EQU     *
  313  9:000230  3E1F                         MOVE.W  (SP)+,D7
  314  9:000232  9E41                         SUB.W   D1,D7
  315  9:000234  E24?                         ASR.W   #1,D7
  316  9:000236  6404                         BCC.S   PDON_9
```

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```
P L O T   D O N E
  317  9:000238  5342          SUBQ.W  #1,D2
  318  9:00023A  6008          BRA.S   PDON_11
```

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```
P L O T   D O N E
 320  9:00023C  4A42              PDON_9  TST.W   D2
 321  9:00023E  6602                      BNE.S   PDON_10
 322  9:000240  3447                      MOVE.W  D7,A2
 323  9:000242  5242              PDON_10 ADDQ.W  #1,D2
 324  9:000244                    PDON_11 EQU     *
 325  9:000244  3E1F                      MOVE.W  (SP)+,D7
 326  9:000246  9E41                      SUB.W   D1,D7
 327  9:000248  E247                      ASR.W   #1,D7
 328  9:00024A  6504                      BCS.S   PDON_12
 329  9:00024C  5242                      ADDQ.W  #1,D2
 330  9:00024E  603A                      BRA.S   PDON_15
 331  9:000250  5342              PDON_12 SUBQ.W  #1,D2
 332  9:000252  6636                      BNE.S   PDON_15
 333  9:000254  BE4A                      CMP.W   A2,D7
 334  9:000256  6F32                      BLE.S   PDON_15
 335  9:000258  3407                      MOVE.W  D7,D2
 336  9:00025A  B044                      CMP.W   D4,D0
 337  9:00025C  6714                      BEQ.S   PDON_14
 349  9:00025E  5344              PDON_13 SUBQ.W  #1,D4
 350  9:000260  B044                      CMP.W   D4,D0
 351  9:000262  670E                      BEQ.S   PDON_14
 352  9:000264  5285           +          ADDQ.L  #1,D5
 352  9:000266  5586           +          SUBQ.L  #SHORT,D6
 352  9:000268  6C02           +          BGE.S   *+4
 352  9:00026A  6158           +          BSR.S   MORE_MEMO
 352  9:00026C  38FCDFFF       +          MOVE.W  #BLANK_RASTER,(A4)+
 353  9:000270  60EC                      BRA     PDON_13
```

```
L O T   D O N E
356  9:000272                     PDON_14 EQU      *
357  9:000272  5285            +          ADDQ.L   #1,D5
357  9:000274  5586            +          SUBQ.L   #SHORT,D6
357  9:000276  6C02            +          BGE.S    *+4
357  9:000278  614A            +          BSR.S    MORE_MEMO
357  9:00027A  38CA            +          MOVE.W   A2,(A4)+
358  9:00027C  5285            +          ADDQ.L   #1,D5
358  9:00027E  5586            +          SUBQ.L   #SHORT,D6
358  9:000280  6C02            +          BGE.S    *+4
358  9:000282  6140            +          BSR.S    MORE_MEMO
358  9:000284  38C2            +          MOVE.W   D2,(A4)+
359  9:000286  2C4C                       MOVE.L   A4,A6
360  9:000288  4242                       CLR.W    D2
361  9:00028A  5943               PDON_15 SUBQ.W   #2*SHORT,D3
362  9:00028C  66A2                       BNE      PDON_8
363  9:00028E  2E0E                       MOVE.L   A6,D7
364  9:000290  672A                       BEQ.S    PDON_18
365  9:000292  41EEFFFE                   LEA      -SHORT(A6),A0
367  9:000296  3E3CE000                   MOVE.W   #$E000,D7
368  9:00029A  CE50                       AND.W    (A0),D7
369  9:00029C  0C47C000                   CMPI.W   #END_MEMO$$E000,D7
370  9:0002A0  6706                       BEQ.S    PDON_16
371  9:0002A2  6208                       BHI.S    PDON_17
373  9:0002A4  00508000                   ORI.W    #END_RASTER,(A0)
374  9:0002A8  6000FE86           PDON_16 BRA      PDON_1
376  9:0002AC                     PDON_17 EQU      *
377  9:0002AC  5285            +          ADDQ.L   #1,D5
377  9:0002AE  5586            +          SUBQ.L   #SHORT,D6
377  9:0002B0  6C02            +          BGE.S    *+4
377  9:0002B2  6110            +          BSR.S    MORE_MEMO
377  9:0002B4  38FCDFFF        +          MOVE.W   #BLANK_RASTER,(A4)+
378  9:0002B8  2C4C                       MOVE.L   A4,A6
379  9:0002BA  60EC                       BRA      PDON_16
381  9:0002BC  5344               PDON_18 SUBQ.W   #1,D4
382  9:0002BE  3B44001C                   MOVE.W   D4,MAX_RASTER(A5)
383  9:0002C2  60E4                       BRA      PDON_16
```

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```
M O    R E   M E M O
                                   *      M O R E _ M E M O
                                   *

  9:0002C4   38FCDFFE              MORE_MEMO MOVE.W  #END_MEMO,(A4)+
  9:0002C8   2C4C                            MOVE.L  A4,A6
  9:0002CA   5285                            ADDQ.L  #1,D5
  9:0002CC   48E7FFF6                        MOVEM.L D0-D7/A0-A3/A5-A6,-(SP)
  9:0002D0   598F                            SUBQ.L  #LONG,SP
  9:0002D2   4857                            PEA     (SP)
  9:0002D4   4CF928000000000000              MOVEM.L PASCAL_REGISTERS,PSCL_RCLST
  9:0002DC   4EB900000000                    JSR     M_NEXT
  9:0002E2   48F928000000000000              MOVEM.L PSCL_RCLST,PASCAL_REGISTERS
  9:0002EA   285F                            MOVE.L  (SP)+,A4
  9:0002EC   4CDF6FFF                        MOVEM.L (SP)+,D0-D7/A0-A3/A5-A6
  9:0002F0   7CFE                            MOVEQ.L #-SHORT,D6
  9:0002F2   DCB900000404                    ADD.L   MEMO_LENGTH,D6
  9:0002F8   2E0C                            MOVE.L  A4,D7
  9:0002FA   6746                            BEQ.S   PDON_S1
  9:0002FC   4E75                            RTS

  9:0002FE   48E7FFFE              PDON_S0   MOVEM.L D0-D7/A0-A6,-(SP)
  9:000302   598F                            SUBQ.L  #LONG,SP
  9:000304   48780011                        PEA     FONTERR
  9:000308   486F0004                        PEA     LONG(SP)
  9:00030C   4EB900000000                    JSR     MEWA
  9:000312   2E83                            MOVE.L  A0,(SP)
  9:000314   207900000000                    MOVE.L  PCHPAR,A0
  9:00031A   317C00110012                    MOVE.W  #FONTERR,ERRORNR(A0)
  9:000320   2E28000E                        MOVE.L  MCBADR(A0),D7
  9:000324   205F                            MOVE.L  (SP)+,A0
  9:000326   2F07                            MOVE.L  D7,-(SP)
  9:000328   4CF928000000000000              MOVEM.L PASCAL_REGISTERS,PSCL_RCLST
  9:000330   4EB900000000                    JSR     M_KILL
  9:000336   48F928000000000000              MOVEM.L PSCL_RCLST,PASCAL_REGISTERS
  9:00033E   4CDF7FFF                        MOVEM.L (SP)+,D0-D7/A0-A6
  9:000342   6148                  PDON_S1   BSR.S   PLOT_CLEAR
  9:000344   6000FE62                        BRA     PDON_4
```

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RELEASE QUEUE

```
                                *       R E L E A S E _ Q U E U E
                                *
9:000348                  +             SECTION 09            * CODE SECTION
9:000348                        RELEASE_QUEUE EQU      *
9:000348  4852                          PEA      (A2)
9:00034A  3F00                          MOVE.W   D0,-(SP)
9:00034C  303C0100                      MOVE.W   #1<<PQSS_SGMNT,D0
9:000350  247C00000000                  MOVE.L   #PQQSL_SEGMENT,A2
9:000356  2E12                  RELQ_1  MOVE.L   (A2),D7
9:000358  670E                          BEQ.S    RELQ_2
9:00035A  2047            +             MOVE.L   D7,A0                 ** RELEASE THIS SEGMENT
9:00035C  2E3C00000500    +             MOVE.L   #PQSSK_LENGTH,D7      * *
9:000362  4EB900000000    +             JSR      AFREE                 ** RETURN BLOCK TO POOL
9:000368  429A                  RELQ_2  CLR.L    (A2)+
9:00036A  5340                          SUBQ.W   #1,D0
9:00036C  66E8                          BNE      RELQ_1
9:00036E  301F                          MOVE.W   (SP)+,D0
9:000370  245F                          MOVE.L   (SP)+,A2
9:000372  4E75                          RTS
```

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```
T   C L E A R
                                      *       P L O T _ C L E A R
                                      *
                                              XDEF      PLOT_CLEAR
9:000374                      +               SECTION   09          * CODE SECTION
9:000374  61D2                        PCLR_0  BSR       RELEASE_QUEUE
9:000376  2B7C7FFF7FFF0018                    MOVE.L    #07FFF7FFF,MIN_Y(A5)
9:00037E  2B7C80008000001C                    MOVE.L    #080008000,MAX_Y(A5)
9:000386  301F                                MOVE.W    (SP)+,D0
9:000388  245F                                MOVE.L    (SP)+,A2
9:00038A  4E75                                RTS
9:00038C                              PLOT_CLEAR EQU    *
9:00038C  4852                                PEA       (A2)
9:00038E  3F00                                MOVE.W    D0,-(SP)
9:000390  422D002D                            CLR.B     LOOP_NOT_CLOSED(A5)
9:000394  302D001C                            MOVE.W    MAX_RASTER(A5),D0
9:000398  5240                                ADDQ.W    #1,D0
9:00039A  5340                        PCLR_1  SUBQ.W    #1,D0
9:00039C  B06D0018                            CMP.W     MIN_RASTER(A5),D0
9:0003A0  6DD2                                BLT       PCLR_0
9:0003A2  3E00                +               MOVE.W    D0,D7
9:0003A4  E04F                +               LSR.W     #PQSV_SGMNT,D7
9:0003A6  E54F                +               LSL.W     #2,D7
9:0003A8  41F900000000        +               LEA.L     PQSL_SEGMENT,A0
9:0003AE  45F07000            +               LEA.L     0(A0,D7.W),A2
9:0003B2  2E12                +               MOVE.L    (A2),D7
9:0003B4  6606                                BNE.S     PCLR_2
9:0003B6  0240FF00                            ANDI.W    #PQSM_SGMNT,D0
9:0003BA  60DE                                BRA       PCLR_1
9:0003BC  2447                        PCLR_2  MOVE.L    D7,A2
9:0003BE  3E00                +               MOVE.W    D0,D7
9:0003C0  024700FF            +               ANDI.W    #PQSM_LINE,D7
9:0003C4  E54F                +               LSL.W     #2,D7
9:0003C6  41EA0100            +               LEA.L     PQSOL_LINE(A2),A0
9:0003CA  41F07000            +               LEA.L     0(A0,D7.W),A0
9:0003CE  2050                +               MOVE.L    (A0),A0
9:0003D0  2E08                        PCLR_3  MOVE.L    A0,D7
9:0003D2  67C6                                BEQ       PCLR_1
9:0003D4  2450                                MOVE.L    (A0),A2
                              +       * ADDRESS TO FREE IN LONGWORD A0
9:0003D6  7E10                +               MOVE.L    #PQLSK_LENGTH,D7         * *
9:0003D8  4EB900000000        +               JSR       AFREE                    ** RETURN BLOCK TO POOL
9:0003DE  204A                                MOVE.L    A2,A0
9:0003E0  60EE                                BRA       PCLR_3
```

ICK SORT

```
                                      *       Q U I C K _ S O R T
                                      *
                                      *CALL FRAME
00000008                                      OFFSET  2*SHORT+LONG          * AREA FOR OLD I, J, PC
00000008                              LEFT    DS.W    1                     * BYTE OFFSET FOR LEFT END
0000000A                              RIGHT   DS.W    1                     * BYTE OFFSET FOR RIGHT END
 9:0003E2                         +           SECTION #9            * CODE SECTION
 9:0003E2                             QUICK_SORT EQU  *
 9:0003E2  48A73000                           MOVEM.W D2/D3,-(SP)
 9:0003E6  342F0008                           MOVE.W  LEFT(SP),D2
 9:0003EA  362F000A                           MOVE.W  RIGHT(SP),D3
 9:0003EE  3E02                               MOVE.W  D2,D7
 9:0003F0  DE43                               ADD.W   D3,D7
 9:0003F2  E44F                               LSR.W   #2,D7
 9:0003F4  DE47                   +           ADD.W   D7,D7
 9:0003F6  3E317000                           MOVE.W  0(A1,D7.W),D7
 9:0003FA  BE712000                   QSRT_1  CMP.W   0(A1,D2.W),D7
 9:0003FE  6F04                               BLE.S   QSRT_2
 9:000400  5442                               ADDQ.W  #SHORT,D2
 9:000402  60F6                               BRA     QSRT_1
 9:000404  BE713000                   QSRT_2  CMP.W   0(A1,D3.W),D7
 9:000408  6C04                               BGE.S   QSRT_3
 9:00040A  5543                               SUBQ.W  #SHORT,D3
 9:00040C  60F6                               BRA     QSRT_2
 9:00040E  B642                       QSRT_3  CMP.W   D2,D3
 9:000410  6D18                               BLT.S   QSRT_5
 9:000412  670E                               BEQ.S   QSRT_4
 9:000414  3F312000                           MOVE.W  0(A1,D2.W),-(SP)
 9:000418  33B130002000                       MOVE.W  0(A1,D3.W),0(A1,D2.W)
 9:00041E  339F3000                           MOVE.W  (SP)+,0(A1,D3.W)
 9:000422  5442                       QSRT_4  ADDQ.W  #SHORT,D2
 9:000424  5543                               SUBQ.W  #SHORT,D3
 9:000426  B642                               CMP.W   D2,D3
 9:000428  6CD0                               BGE     QSRT_1
 9:00042A  3E2F0008                   QSRT_5  MOVE.W  LEFT(SP),D7
 9:00042E  B647                               CMP.W   D7,D3
 9:000430  6F08                               BLE.S   QSRT_6
 9:000432  3F03                               MOVE.W  D3,-(SP)
 9:000434  3F07                               MOVE.W  D7,-(SP)
 9:000436  61AA                               BSR     QUICK_SORT
 9:000438  508F                   +           ADDQ.L  #2*SHORT,SP
 9:00043A  3E2F000A                   QSRT_6  MOVE.W  RIGHT(SP),D7
 9:00043E  BE42                               CMP.W   D2,D7
 9:000440  6F08                               BLE.S   QSRT_7
 9:000442  3F07                               MOVE.W  D7,-(SP)
 9:000444  3F02                               MOVE.W  D2,-(SP)
 9:000446  619A                               BSR     QUICK_SORT
 9:000448  508F                   +           ADDQ.L  #2*SHORT,SP
 9:00044A  4C9F000C                   QSRT_7  MOVEM.W (SP)+,D2/D3
 9:00044E  4E75                               RTS
```

CLEAR_SEGMENT

```
                                  XDEF CLEAR_SEGMENT
000450                   CLEAR_SEGMENT EQU       *
000450  4850                      PEA      (A0)
000452  41F900000000              LEA.L    PQOSL_SEGMENT,A0
000458  3E3C0100                  MOVE.W   #1<<PQOS_SGMNT,D7
00045C  4298                      CLR.L    (A0)+
00045E  5947                      SUBQ.W   #LONG,D7
000460  66FA                      BNE      *-4
000462  205F                      MOVE.L   (SP)+,A0
000464  4E75                      RTS

                                  END
```

```
S T O R A G E   ALLOCATION & FREE
                        STORAGE IDNT 1,0 CURVE FONT MEMORY MANAGER
00                      HUNK    SET     $1000           * 4K BYTE CHUNKS

                        *       FREE HOLE STRUCTURE
                        *
00                              OFFSET  0
00                      FREESL_PTR: DS.L        1
04                      FREESL_SIZE: DS.L       1
08                      FREESL_LENGTH: EQU      *

                                XDEF    AALLOC,AFREE,STOR_INIT,STOR_FINAL
                                XDEF    PLOT_AREA,FIRST_SEGMENT,FIRST_LENGTH
                                XREF    PASCAL_REGISTERS,FETCH_MEM,DISP_MEM,MEWA,PCHPAR,CRV_ERROR
                                XREF    M_KILL
00                    +         SECTION $7              * DATA SECTION:
00  00000000            PLOT_AREA: DC.L         0
04  00000000            FIRST_SEGMENT DC.L      0
08  00000000            FIRST_LENGTH DC.L       0
0C                    +         DS.W    0
```

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AALLOC

```
                                   *CALL FRAME
                                   * D7(0:31)=      NUMBER OF BYTES NEEDED
                                   *
                                   *RETURN FRAME
                                   * D7(0:31)=      --) TO BASE OF HOLE
                                   *
                                   *REGISTERS DESTROYED    -       NONE

9:000000                        +          SECTION 09               * CODE SECTION
9:000000                           AALLOC: EQU      *
9:000000 48E780C0                          MOVEM.L D0/A0/A1,-(SP)      * SAVE REGISTERS
9:000004 7008                              MOVEQ.L #FREESK_LENGTH,D0
9:000006 BE80                              CMP.L   D0,D7
9:000008 6306                              BLS.S   ALC8_1                * REQUEST IS TO SMALL
9:00000A 5287                              ADDQ.L  #1,D7
9:00000C 70FE                              MOVEQ.L #-2,D0
9:00000E C087                              AND.L   D7,D0
9:000010 207900000000              ALC8_1: MOVE.L  .PLOT_AREA,A0
9:000016 2248                              MOVE.L  A0,A1
9:000018 2E08                      ALC8_2: MOVE.L  A0,D7
9:00001A 6739                              BEQ.S   ALC8_7                * END OF CHAIN GET MORE MEMORY
9:00001C 2E280004                          MOVE.L  FREESL_SIZE(A0),D7
9:000020 9E80                              SUB.L   D0,D7
9:000022 670A                              BEQ.S   ALC8_3                * EXACT FIT
9:000024 5187                              SUBQ.L  #FREESK_LENGTH,D7
9:000026 6C14                              BGE.S   ALC8_5                * LARGE ENOUGH
9:000028 2248                              MOVE.L  A0,A1
9:00002A 2050                              MOVE.L  (A0),A0
9:00002C 60EA                              BRA.S   ALC8_2
9:00002E B1C9                      ALC8_3: CMP.L   A1,A0
9:000030 6606                              BNE.S   ALC8_4                * NOT TOP TO LIST
9:000032 43F900000000                      LEA.L   PLOT_AREA,A1
9:000038 2290                      ALC8_4: MOVE.L  (A0),(A1)               * REMOVE THIS CHUNK FROM LIST
9:00003A 6008                              BRA.S   ACL8_6
9:00003C 91A80004                  ALC8_5: SUB.L   D0,FREESL_SIZE(A0)   * DECREASE THIS HOLE BY LENGTH
9:000040 D1E80004                          ADD.L   FREESL_SIZE(A0),A0      * P --) FREE HOLE
9:000044 2E08                      ACL8_6: MOVE.L  A0,D7
9:000046 4CDF0301                          MOVEM.L (SP)+,D0/A0/A1       * RESTORE REGISTERS
9:00004A 4E75                              RTS
```

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A A L L O C

```
9:00004C 43F80FF8              ALCB_7: LEA.L   HUNK-FREESK_LENGTH,A1
9:000050 B089                          CMP.L   A1,D0
9:000052 6504          +               BCS.S   ALCB_8          * LOWER
9:000054 2240                          MOVE.L  D0,A1
9:000056 6002                          BRA.S   ALCB_9
9:000058 5089                  ALCB_8: ADDQ.L  #FREESK_LENGTH,A1
9:00005A 2E09                  ALCB_9: MOVE.L  A1,D7
9:00005C 0687000003FF                  ADD.L   #1023,D7
9:000062 E08F                          LSR.L   #8,D7
9:000064 E48F                          LSR.L   #10-8,D7
9:000066 48E7FF7E                      MOVEM.L D0-D7/A1-A6,-(SP)
9:00006A 598F                          SUBQ.L  #LONG,SP                 * MAKE ROOM FOR POINTER TO NEW
9:00006C 4857                          PEA.L   (SP)                     *\
9:00006E 2F07                          MOVE.L  D7,-(SP)                 * >GET NEW MEMORY
9:000070 4CF928000000000000            MOVEM.L PASCAL_REGISTERS,PSCL_RCLST
9:000078 4EB900000000                  JSR     FETCH_MEM                *∕
9:00007E 48F928000000000000            MOVEM.L PSCL_RCLST,PASCAL_REGISTERS
9:000086 205F                          MOVE.L  (SP)+,A0
9:000088 4CDF7EFF                      MOVEM.L (SP)+,D0-D7/A1-A6
9:00008C 2E09                          MOVE.L  A1,D7                    * LENGTH OF THIS HOLE
9:00008E 51ED002C                      SF      USED_1_SEGMENT(A5)
9:000092 610C                          BSR.S   AFRE_0
9:000094 6000FF7A                      BRA     ALCB_1
```

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A F R E E

```
                                   *CALL FRAME
                                   * D7(00:31)=SIZE OF HOLE
                                   * P(A0)--) HOLE
                                   *
                                   *RETURN FRAME
                                   *
                                   *REGISTERS DESTROYED     -       D7

9:000098                                     SECTION 09              * CODE SECTION
9:000098  4A2D002C                 AFREE:    TST.B    USED_1_SEGMENT(A5)
9:00009C  6702                               BEQ.S    AFRE_0
9:00009E  4E75                               RTS
9:0000A0  48E78060                 AFRE_0:   MOVEM.L  D0/A1/A2,-(SP)
9:0000A4  7008                               MOVEQ.L  #FREESK_LENGTH,D0
9:0000A6  BE80                               CMP.L    D0,D7
9:0000A8  6306                               BLS.S    AFRE_1
9:0000AA  5287                               ADDQ.L   #1,D7
9:0000AC  70FE                               MOVEQ.L  #-2,D0
9:0000AE  C087                               AND.L    D7,D0
9:0000B0  247900000000             AFRE_1:   MOVE.L   PLOT_AREA,A2
9:0000B6  224A                               MOVE.L   A2,A1
9:0000B8  2E0A                     AFRE_2:   MOVE.L   A2,D7
9:0000BA  670A                               BEQ.S    AFRE_3               * END OF CHAIN
9:0000BC  B1CA                               CMP.L    A2,A0
9:0000BE  6306                               BLS.S    AFRE_3               * FOUND WHERE IT GOES
9:0000C0  224A                               MOVE.L   A2,A1
9:0000C2  2452                               MOVE.L   (A2),A2
9:0000C4  60F2                               BRA      AFRE_2
9:0000C6  2E09                     AFRE_3:   MOVE.L   A1,D7
9:0000C8  6704                               BEQ.S    AFRE_4               * 1ST HOLE
9:0000CA  B1C9                               CMP.L    A1,A0
9:0000CC  6206                               BHI.S    AFRE_5               * NOT NEW TOP
9:0000CE  23C800000000             AFRE_4:   MOVE.L   A0,PLOT_AREA          * SET NEW TOP
9:0000D4  2E00                     AFRE_5:   MOVE.L   D0,D7
9:0000D6  DE88                               ADD.L    A0,D7
9:0000D8  B5C7                               CMP.L    D7,A2
9:0000DA  6608                               BNE.S    AFRE_6               * COLLAPSE FORWARD HOLE
9:0000DC  2092                               MOVE.L   (A2),(A0)
9:0000DE  D0AA0004                           ADD.L    FREESL_SIZE(A2),D0
9:0000E2  6008                               BRA.S    AFRE_8
```

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```
\ F R E E
9:0000E4   6204                 AFRE_6: BHI.S    AFRE_7
9:0000E6   2E0A                         MOVE.L   A2,D7
9:0000E8   6623                         BNE.S    AFRE_20                 * TRAP ON TROUBLE
9:0000EA   208A                 AFRE_7: MOVE.L   A2,(A0)                   * INSERT THIS HOLE
9:0000EC   2E09                 AFRE_8: MOVE.L   A1,D7
9:0000EE   6718                         BEQ.S    AFRE_10
9:0000F0   B1C9                         CMP.L    A1,A0
9:0000F2   6314                         BLS.S    AFRE_10
9:0000F4   DEA90004                     ADD.L    FREESL_SIZE(A1),D7
9:0000F8   B1C7                         CMP.L    D7,A0
9:0000FA   6608                         BNE.S    AFRE_9                  * NO COLLAPSE BACKWARD
9:0000FC   2299                         MOVE.L   (A0),(A1)
9:0000FE   D1A90004                     ADD.L    D0,FREESL_SIZE(A1)
9:000102   6008                         BRA.S    AFRE_11
9:000104   630C                 AFRE_9: BLS.S    AFRE_20                 * TRAP ON TROUBLE
9:000106   2288                         MOVE.L   A0,(A1)                   * PREVIOUS LINK TO NEW
9:000108   21400004             AFRE_10 MOVE.L   D0,FREESL_SIZE(A0)
9:00010C   4CDF0601             AFRE_11 MOVEM.L  (SP)+,D0/A1/A2
9:000110   4E75                         RTS

9:000112   207900000000         AFRE_20 MOVE.L   PCHPAR,A0
9:000118   317C004B0012                 MOVE.W   #PARERR,ERRORNR(A0)
9:00011E   598F                         SUBQ.L   #LONG,SP
9:000120   487C004B                     PEA      PARERR
9:000124   486F0004                     PEA      LONG(SP)
9:000128   4EB900000000                 JSR      MEWA
9:00012E   207900000000                 MOVE.L   PCHPAR,A0
9:000134   2F28000E                     MOVE.L   MCBADR(A0),-(SP)
9:000138   4CF9280000000000             MOVEM.L  PASCAL_REGISTERS,PSCL_RGLST
9:000140   4EB900000000                 JSR      M_KILL
9:000146   48F9280000000000             MOVEM.L  PSCL_RGLST,PASCAL_REGISTERS
9:00014E   4EF900000000                 JMP      CRV_ERROR
```

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I N I T I A L I Z A T I O N

```
9:000154  4A2D002C                 STOR_FINAL TST.B USED_1_SEGMENT(A5)
9:000158  6702                                BEQ.S    *+4
9:00015A  605E                                BRA.S    STOR_INIT
9:00015C  48E70380                            MOVEM.L  D6/D7/A0,-(SP)
9:000160  207900000000             STFIN_1    MOVE.L   PLOT_AREA,A0
9:000166  2E18                                MOVE.L   (A0)+,D7
9:000168  674C                                BEQ.S    STFIN_2
9:00016A  23C700000000                        MOVE.L   D7,PLOT_AREA
9:000170  BEB900000004                        CMP.L    FIRST_SEGMENT,D7
9:000176  67E8                                BEQ.S    STFIN_1
9:000178  48E7FEFE                            MOVEM.L  D0-D6/A0-A6,-(SP)
9:00017C  2F07                                MOVE.L   D7,-(SP)
9:00017E  4857                                PEA      (SP)
9:000180  2E10                                MOVE.L   (A0),D7          * LENGTH OF PARTITION
9:000182  0287000003FF                        AND.L    #1023,D7
9:000188  6688                                BNE      AFRE_20          * PARTITION WAS NOT CLOSED
9:00018A  2E10                                MOVE.L   (A0),D7
9:00018C  0687000003FF                        ADD.L    #1023,D7
9:000192  E08F                                LSR.L    #8,D7
9:000194  E48F                                LSR.L    #10-8,D7
9:000196  2F07                                MOVE.L   D7,-(SP)
9:000198  4CF9280000000000                    MOVEM.L  PASCAL_REGISTERS,PSCL_RCLST
9:0001A0  4EB900000000                        JSR      DISP_MEM
9:0001A6  48F9280000000000                    MOVEM.L  PSCL_RCLST,PASCAL_REGISTERS
9:0001AE  588F                                ADDQ.L   #LONG,SP
9:0001B0  4CDF7F7F                            MOVEM.L  (SP)+,D0-D6/A0-A6
9:0001B4  60AA                                BRA      STFIN_1
9:0001B6  4CDF01C0                 STFIN_2    MOVEM.L  (SP)+,D6/D7/A0

9:0001BA  4850                     STOR_INIT  PEA      (A0)
9:0001BC  2E3900000004             STINT_1    MOVE.L   FIRST_SEGMENT,D7
9:0001C2  6718                                BEQ.S    STINT_2
9:0001C4  2047                                MOVE.L   D7,A0
9:0001C6  23C800000000                        MOVE.L   A0,PLOT_AREA
9:0001CC  4298                                CLR.L    (A0)+
9:0001CE  20B900000008                        MOVE.L   FIRST_LENGTH,(A0)
9:0001D4  50ED002C                            ST.B     USED_1_SEGMENT(A5)
9:0001D8  205F                                MOVE.L   (SP)+,A0
9:0001DA  4E75                                RTS
9:0001DC  48E7FFFE                 STINT_2    MOVEM.L  D0-D7/A0-A6,-(SP)
9:0001E0  487900000004                        PEA.L    FIRST_SEGMENT
9:0001E6  48780014                            PEA      20
9:0001EA  4CF9280000000000                    MOVEM.L  PASCAL_REGISTERS,PSCL_RCLST
9:0001F2  4EB900000000                        JSR      FETCH_MEM
9:0001F8  48F9280000000000                    MOVEM.L  PSCL_RCLST,PASCAL_REGISTERS
9:000200  4CDF7FFF                            MOVEM.L  (SP)+,D0-D7/A0-A6
9:000204  23FC0000500000000                   MOVE.L   #20*1024,FIRST_LENGTH
9:00020E  60AC                                BRA      STINT_1

                                              END
```

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T R I C   F U N C T I O N S

```
                TRIC      IDNT 1.0 CURVE FONT ARCTANGENT/SINE/COSINE FUNCTIONS

                *         ANGULAR CONSTANTS
000000A0        HDEG_80:        SET     80*2
000000B3        HDEG_89P5:      SET     89*2+1
000000B4        HDEG_90:        SET     90*2
00000168        HDEG_180:       SET     HDEG_90*2
000002D0        HDEG_360:       SET     HDEG_180*2
```

A R C T A N G E N T

```
                                   *       A R C T A N
                                   *
                                   *CALL FRAME
                                   * D7(16:31)= DELTA Y
                                   * D7(00:15)= DELTA X
                                   *
                                   *RETURN FRAME
                                   * D7(00:31)= ARCTANGENT ANGLE IN 1/2 DEGREES
                                   *
                                   *REGISTERS DESTROYED    -       NONE
                                   *REGISTERS USED         -       DELTA_Y(D0)/D7/A0
                                   *
                                   *FUNCTION
                                   * GIVEN DELTA_Y AND DELTA_X A ANGLE IN 1/2 DEGREES IS RETURNED BY TAKING
                                   * THE SLOPE (IE ABS(DELTA_Y)/ABS(DELTA_X)) AND LOOKING IT UP INTO A TABLE.
                                   * THE TABLES ARE BROKEN INTO 3 PARTS.
                                   * 1)    ARCTANGENT(SLOPE) 0<=SLOPE<2 BY 1/128S
                                   * 2)    ARCTANGENT(SLOPE) 2<=SLOPE<6 BY 1/64S
                                   * 3)    TANGENT(THETA) 80<=THETA<=89 BY 1/2DEGS
                                   * FINALLY THE SIGNS OF DELTA_X AND DELTA_Y ARE USED TO SET THE QUADRANT
                                   * OF THE RETURN VALUE
                                   *
                                   *REGISTERS
                                   *DELTA_Y          SET     D0
                                   *DELTA_Y.W        SET     D0.W

                                           XDEF    ARCTAN                  * ARCTANGENT FUNCTION
                                           XREF    ATN_0_2,ATN_2_6,TAN_80_89       * FROM TABLES
9:000000                                   SECTION 09              * CODE SECTION
9:000000                           ARCTAN: EQU     *
9:000000  48E78080                         MOVEM.L D0/A0,-(SP)
9:000004  2007                             MOVE.L  D7,D0                   * D7=X
9:000006  4840                             SWAP    D0              * DELTA_Y=Y
9:000008  2F00                             MOVE.L  D0,-(SP)        * PUSH ON DELTA_X/DELTA_Y
9:00000A  48C0                             EXT.L   D0
9:00000C  661A                             BNE.S   ARCTN_3                 * THERE IS A Y
9:00000E  7E00                             MOVEQ.L #0,D7
9:000010  4A5F                     ARCTN_1 TST.W   (SP)+                   * IS X<0
9:000012  6A06                             BPL.S   ARCTN_2
9:000014  4447                             NEG.W   D7
9:000016  06470168                         ADDI.W  #HDEG_180,D7
9:00001A  4A5F                     ARCTN_2 TST.W   (SP)+                   * IS Y<0
9:00001C  6A02                             BPL.S   *+4
9:00001E  4447                             NEG.W   D7
9:000020  4CDF0101                         MOVEM.L (SP)+,D0/A0
9:000024  48C7                             EXT.L   D7
9:000026  4E75                             RTS
```

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```
 CTANGENT
 62   9:000028                       ARCTN_3 EQU     *
 63   9:000028  6A02             +           BPL.S   *+4
 63   9:00002A  4480             +           NEG.L   D0
 64   9:00002C  48C7                         EXT.L   D7
 65   9:00002E  6606                         BNE.S   ARCTN_4
 66   9:000030  3E3C00B4                     MOVE.W  #HDEG_90,D7
 67   9:000034  60DA                         BRA     ARCTN_1
 68   9:000036                       ARCTN_4 EQU     *
 69   9:000036  6A02             +           BPL.S   *+4
 69   9:000038  4487             +           NEG.L   D7
 70   9:00003A  2047                         MOVE.L  D7,A0                    * SAVE X
 71   9:00003C  D1C8                         ADD.L   A0,A0                    * X*2
 72   9:00003E  B1C0                         CMP.L   D0,A0                      * Y < 2*X
 73   9:000040  6312                         BLS.S   ARCTN_6
 74   9:000042  EF80                         ASL.L   #7,D0
 75   9:000044  41F900000000                 LEA.L   ATN_0_2,A0
 76   9:00004A  80C7                 ARCTN_5 DIVU    D7,D0
 77                              +   * D0 ALREADY INDEX TO CHAR               * OFFSET BY BYTES
 78   9:00004C  7E00                         MOVEQ.L #0,D7
 79   9:00004E  1E300000                     MOVE.B  0(A0,D0.W),D7
 80   9:000052  60BC                         BRA     ARCTN_1                  * SET QUADRANT
 81   9:000054  D1C7                 ARCTN_6 ADD.L   D7,A0                    * X*3
 82   9:000056  D1C8                         ADD.L   A0,A0                    * X*6
 83   9:000058  B1C0                         CMP.L   D0,A0                      * Y < 6*X
 84   9:00005A  630A                         BLS.S   ARCTN_7
 85   9:00005C  ED80                         ASL.L   #6,D0                      * Y*64
 86   9:00005E  41F9FFFFFF80                 LEA.L   ATN_2_6-128*CHAR,A0
 87   9:000064  60E4                         BRA     ARCTN_5
 88   9:000066  2047                 ARCTN_7 MOVE.L  D7,A0
 89   9:000068  EF87                         ASL.L   #16-9,D7
 90   9:00006A  BE80                         CMP.L   D0,D7
 91   9:00006C  6316                         BLS.S   ARCTN7A
 92   9:00006E  2E08                         MOVE.L  A0,D7
 93   9:000070  E180                         ASL.L   #8,D0
 94   9:000072  E389                         ASL.L   #9-8,D0
 95   9:000074  80C7                         DIVU    D7,D0
 96   9:000076  690C                         BVS.S   ARCTN7A
 97   9:000078  41F900000000                 LEA.L   TAN_80_89,A0
 98   9:00007E  B0680024                     CMP.W   18*SHORT(A0),D0
 99   9:000082  6506                 +       BCS.S   ARCTN_8          * LOWER
100   9:000084  3E3C00B3             ARCTN7A MOVE.W  #HDEG_89P5,D7
101   9:000088  6086                         BRA     ARCTN_1
102   9:00008A  7E12                 ARCTN_8 MOVEQ.L #9*SHORT,D7
103   9:00008C  B0707800                     CMP.W   0(A0,D7.L),D0
104   9:000090  6404                 +       BCC.S   ARCTN10          * HIGH OR SAME
105   9:000092  7EFE                         MOVEQ.L #-SHORT,D7
106   9:000094  5487                 ARCTN_9 ADDQ.L  #SHORT,D7
107   9:000096  B0707800             ARCTN10 CMP.W   0(A0,D7.L),D0
108   9:00009A  62F8                         BHI.S   ARCTN_9
109   9:00009C  E247                         ASR.W   #1,D7                    * UNDO SHORT INDEX
110   9:00009E  064700A0                     ADDI.W  #HDEG_80,D7
111   9:0000A2  6000FF6C                     BRA     ARCTN_1
```

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E / C O S I N E

```
                                    *       S I N E / C O S I N E
                                    *
                                    *CALL FRAME
                                    * D7(0:15)=     +/- THETA IN 1/2 DEGREES
                                    *
                                    *RETURN FRAME
                                    * D7(0:31)=     +/- SINE(THETA)/COSINE(THETA) * 2**-15
                                    *
                                    *REGISTERS DESTROYED   -       NONE
                                    *REGISTERS USED -              D7/A0
                                    *
                                    *FUNCTION
                                    * IF COMPENSATE FOR COSINE              IE. COSINE(THETA)===SINE(THETA+90)
                                    * THE VALUE OF ABS(THETA) MOD 360 IS REDUCED WITHIN RANGE OF (0..90)
                                    * THIS NUMBER IS USED TO LOOKUP INTO A SINE TABLE
                                    * THEN COMPENSATE FOR NEGATIVE THETA     IE. SINE(-THETA)===-SINE(THETA)

                                            XDEF    SINE,COSINE             * SINE / COSINE FUNCTIONS
                                            XREF    SINE_TBL                * FROM TABLES

9:0000A6                     +              SECTION 9               * CODE SECTION
9:0000A6                            COSINE: EQU     *
9:0000A6  064700B4                          ADDI.W  #HDEG_90,D7
9:0000AA                            SINE:   EQU     *
9:0000AA  4850                              PEA.L   (A0)                    * SAVE A0
9:0000AC  41F900000000                      LEA.L   SINE_TBL,A0
9:0000B2  48C7                              EXT.L   D7                      * SET D7(31) TO SIGN OF THETA
9:0000B4  6A02               +              BPL.S   *+4
9:0000B6  4447               +              NEG.W   D7
9:0000B8  044702D0                  SINE_1: SUBI.W  #HDEG_360,D7
9:0000BC  64FA               +              BCC.S   SINE_1          * HIGH OR SAME
9:0000BE  064702D0                          ADDI.W  #HDEG_360,D7
9:0000C2  0C470168                          CMPI.W  #HDEG_180,D7
9:0000C6  6308                              BLS.S   SINE_2
9:0000C8  04470168                          SUBI.W  #HDEG_180,D7
9:0000CC  0847001F                          BCHG.L  #31,D7
9:0000D0  0C4700B4                  SINE_2: CMPI.W  #HDEG_90,D7
9:0000D4  6306                              BLS.S   SINE_3
9:0000D6  4447                              NEG.W   D7
9:0000D8  06470168                          ADDI.W  #HDEG_180,D7
9:0000DC                            SINE_3: EQU     *
9:0000DC  DE47               +              ADD.W   D7,D7
9:0000DE  3E307000                          MOVE.W  0(A0,D7.W),D7
9:0000E2  205F                              MOVE.L  (SP)+,A0
9:0000E4  4A87                              TST.L   D7
9:0000E6  6A02               +              BPL.S   *+4
9:0000E8  4447               +              NEG.W   D7
9:0000EA  48C7                              EXT.L   D7
9:0000EC  4E75                              RTS
```

D ANGLE

```
                                   *       F O L D _ A N G L E
                                   *
                                   *CALL FRAME
                                   * D7=   DELTA_ANGLE = ANGLE2-ANGLE1     ANGLE2.ANGLE1=(-180..+180)
                                   *
                                   *RETURN FRAME
                                   * D7=   DELTA_ANGLE SUCH THAT DELTA_ANGLE=(-180..+180)
                                   *
                                   *REGISTERS DESTROYED    -        NONE
                                   *REGISTERS USED -                D7
                                   *
                                   *FUNCTION
                                   * IF DELTA ANGLE > 180 THEN -360;RETURN
                                   * IF DELTA ANGLE <-180 THEN +360;RETURN

                                           XDEF     FOLD_ANGLE

9:0000EE                     +             SECTION 09            * CODE SECTION
9:0000EE                           FOLD_ANGLE: EQU *
9:0000EE  0C470168                         CMPI.W   #HDEG_180,D7
9:0000F2  6F06                             BLE.S    FANG_1
9:0000F4  044702D0                         SUBI.W   #HDEG_360,D7
9:0000F8  600A                             BRA.S    FANG_2
9:0000FA  0C47FE98                 FANG_1  CMPI.W   #-HDEG_180,D7
9:0000FE  6C04                             BGE.S    FANG_2
9:000100  064702D0                         ADDI.W   #HDEG_360,D7
9:000104  48C7                     FANG_2  EXT.L    D7
9:000106  4E75                             RTS

                                           END
```

-VII-

```
only Trig Tables
angent Tables
.     9    Arctangent Tables
.    86    Tangent Table
.   111    Sine Table
.   136    Xi Table
                                xdef    atn_0_2,atn_2_6,atn_026,tan_80_89,atn_tan_tbl
                                xdef    sine_tbl,tan_tbl,xi_tbl

:000000             +          section 9C             * Code Section
```

Module -VII-

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R e a d o n l y   T r i g   T a b l e s
A r c t a n g e n t   T a b l e s

```
C:000000                      tan_80_89: equ  *            * tangent of 80..89 by 1/2deg
C:000000  0BA40C480CFF0DCB     dc.w   2980,3144,3327,3531,3762,4025,4326,4675,5085,5572
C:000014  18121AEA1E842339     dc.w   6162,6890,7812,9017,10659,13031,16758,23465,-26424
C:000026                      atn_0_2: equ   *             * arctangent of 0..2 by 1/128
C:000026  0001020304040506     dc.b   0,1,2,3,4,4,5,6
C:00002E  0703090A0B0C0C0D     dc.b   7,8,9,10,11,12,12,13
C:000036  0E0F101112131414     dc.b   14,15,16,17,18,19,20,20
C:00003E  15161718191A1A1B     dc.b   21,22,23,24,25,26,26,27
C:000046  1C1D1E1F1F202122     dc.b   28,29,30,31,31,32,33,34
C:00004E  2324242526272828     dc.b   35,36,36,37,38,39,40,40
C:000056  292A2B2B2C2D2E2F     dc.b   41,42,43,43,44,45,46,47
C:00005E  2F30313132333434     dc.b   47,48,49,49,50,51,52,52
C:000066  353637373839393A     dc.b   53,54,55,55,56,57,57,58
C:00006E  3B3B3C3D3D3E3F3F     dc.b   59,59,60,61,61,62,63,63
C:000076  4041414243434444     dc.b   64,65,65,66,67,67,68,68
C:00007E  4546464747484949     dc.b   69,70,70,71,71,72,73,73
C:000086  4A4A4B4B4C4D4D4E     dc.b   74,74,75,75,76,77,77,78
C:00008E  4E4F4F5050515152     dc.b   78,79,79,80,80,81,81,82
C:000096  5253535454555556     dc.b   82,83,83,84,84,85,85,86
C:00009E  565757585859595A     dc.b   86,87,87,88,88,89,89,90
C:0000A6  5A5A5B5B5C5C5D5D     dc.b   90,90,91,91,92,92,93,93
C:0000AE  5D5E5E5F5F606060     dc.b   93,94,94,95,95,96,96,96
C:0000B6  6161626262636363     dc.b   97,97,98,98,98,99,99,99
C:0000BE  6464656565666666     dc.b   100,100,101,101,101,102,102,102
C:0000C6  6767676868686969     dc.b   103,103,103,104,104,104,105,105
C:0000CE  696A6A6A6B6B6B6C     dc.b   105,106,106,106,107,107,107,108
C:0000D6  6C6C6D6D6D6D6E6E     dc.b   108,108,109,109,109,109,110,110
C:0000DE  6E6F6F6F70707070     dc.b   110,111,111,111,112,112,112,112
C:0000E6  7171717172727273     dc.b   113,113,113,113,114,114,114,115
C:0000EE  7373737474747475     dc.b   115,115,115,116,116,116,116,117
C:0000F6  7575757676767676     dc.b   117,117,117,118,118,118,118,118
C:0000FE  7777777778787878     dc.b   119,119,119,119,120,120,120,120
C:000106  797979797 97A7A7A    dc.b   121,121,121,121,121,122,122,122
C:00010E  7A7A7B7B7B7B7B7C     dc.b   122,122,123,123,123,123,123,124
C:000116  7C7C7C7C7D7D7D7D     dc.b   124,124,124,124,125,125,125,125
C:00011E  7D7E7E7E7E7E7F7F     dc.b   125,126,126,126,126,126,127,127
C:000026                      atn_026: set atn_0_2    * atn_0_2 is followed by atn_2_6
C:000026                      atn_tan_tbl: set atn_0_2     * tan_80_90 is -19 shortwords of tan_0_2
C:000126                      atn_2_6: equ   *             * arctangent 2..6 by 1/64
C:000126  7F7F808080818181     dc.b   127,127,-128,-128,-128,-127,-127,-127
C:00012E  8282828383838384     dc.b   -126,-126,-126,-125,-125,-125,-125,-124
C:000136  8484858585868686     dc.b   -124,-124,-123,-123,-123,-122,-122,-122
C:00013E  8687878787888888     dc.b   -122,-121,-121,-121,-121,-120,-120,-120
C:000146  88898989898A8A8A     dc.b   -120,-119,-119,-119,-119,-118,-118,-118
C:00014E  8A8B8B8B8B8B8C8C     dc.b   -118,-117,-117,-117,-117,-117,-116,-116
C:000156  8C8C8C8D8D8D8D8D     dc.b   -116,-116,-116,-115,-115,-115,-115,-115
C:00015E  8E8E8E8E8E8F8F8F     dc.b   -114,-114,-114,-114,-114,-113,-113,-113
C:000166  8F8F8F9090909090     dc.b   -113,-113,-113,-112,-112,-112,-112,-112
C:00016E  9191919191919192     dc.b   -111,-111,-111,-111,-111,-111,-111,-110
C:000176  9292929292939393     dc.b   -110,-110,-110,-110,-110,-109,-109,-109
C:00017E  9393939394949494     dc.b   -109,-109,-109,-109,-108,-108,-108,-108
C:000186  9494949595959595     dc.b   -108,-108,-108,-107,-107,-107,-107,-107
C:00018E  9595959696969696     dc.b   -107,-107,-107,-106,-106,-106,-106,-106
```

```
leadonly  Trig  Tables
\rotangent  Tables
 C:000196  9696969697979797        dc.b    -106,-106,-106,-106,-105,-105,-105,-105
 C:00019E  9797979797989898        dc.b    -105,-105,-105,-105,-105,-104,-104,-104
 C:0001A6  9898989898989999        dc.b    -104,-104,-104,-104,-104,-104,-103,-103
 C:0001AE  9999999999999999        dc.b    -103,-103,-103,-103,-103,-103,-103,-103
 C:0001B6  9A9A9A9A9A9A9A9A        dc.b    -102,-102,-102,-102,-102,-102,-102,-102
 C:0001BE  9A9A9A9B9B9B9B9B        dc.b    -102,-102,-102,-101,-101,-101,-101,-101
 C:0001C6  9B9B9B9B9B9B9B9C        dc.b    -101,-101,-101,-101,-101,-101,-101,-100
 C:0001CE  9C9C9C9C9C9C9C9C        dc.b    -100,-100,-100,-100,-100,-100,-100,-100
 C:0001D6  9C9C9C9C9D9D9D9D        dc.b    -100,-100,-100,-100,-99,-99,-99,-99
 C:0001DE  9D9D9D9D9D9D9D9D        dc.b    -99,-99,-99,-99,-99,-99,-99,-99
 C:0001E6  9D9D9E9E9E9E9E9E        dc.b    -99,-99,-98,-98,-98,-98,-98,-98
 C:0001EE  9E9E9E9E9E9E9E9E        dc.b    -98,-98,-98,-98,-98,-98,-98,-98
 C:0001F6  9E9E9F9F9F9F9F9F        dc.b    -98,-98,-97,-97,-97,-97,-97,-97
 C:0001FE  9F9F9F9F9F9F9F9F        dc.b    -97,-97,-97,-97,-97,-97,-97,-97
 C:000206  9F9FA0A0A0A0A0A0        dc.b    -97,-97,-96,-96,-96,-96,-96,-96
 C:00020E  A0A0A0A0A0A0A0A0        dc.b    -96,-96,-96,-96,-96,-96,-96,-96
 C:000216  A0A0A0A0A0A1A1A1        dc.b    -96,-96,-96,-96,-96,-95,-95,-95
 C:00021E  A1A1A1A1A1A1A1A1        dc.b    -95,-95,-95,-95,-95,-95,-95,-95
 C:000226                      +           ds.w    0
                               +
 C:000226                          tan_tbl:        equ *          * tangent of 0..90 degrees by 1/2 binary(15,8)
 C:000226  0000000200040007        dc.w    0,2,4,7,9,11,13,16
 C:000236  0012001400160019        dc.w    18,20,22,25,27,29,31,34
 C:000246  002400260029002B        dc.w    36,38,41,43,45,47,50,52
 C:000256  003600390038003D        dc.w    54,57,59,61,64,66,69,71
 C:000266  0049004C004E0051        dc.w    73,76,78,81,83,86,88,91
 C:000276  005D006000620065        dc.w    93,96,98,101,103,106,109,111
 C:000286  007200750077007A        dc.w    114,117,119,122,125,128,130,133
 C:000296  0088008B008E0091        dc.w    136,139,142,145,148,151,154,157
 C:0002A6  00A000A300A600A9        dc.w    160,163,166,169,173,176,179,183
 C:0002B6  00BA00BD00C100C4        dc.w    186,189,193,196,200,204,207,211
 C:0002C6  00D700DB00DF00E2        dc.w    215,219,223,226,231,235,239,243
 C:0002D6  00F700FC01000105        dc.w    247,252,256,261,265,270,275,279
 C:0002E6  011C01210126012C        dc.w    284,289,294,300,305,311,316,322
 C:0002F6  0148014E0154015A        dc.w    328,334,340,346,352,359,366,372
 C:000306  017C0183018A0192        dc.w    380,387,394,402,410,418,426,435
 C:000316  01BB01C401CE01D7        dc.w    443,452,462,471,481,492,502,513
 C:000326  020D021902250232        dc.w    525,537,549,562,575,589,603,618
 C:000336  027A028A029B02AD        dc.w    634,650,667,685,703,723,743,765
 C:000346  0314032C03450360        dc.w    788,812,837,864,893,923,955,990
 C:000356  0403042A04550483        dc.w    1027,1066,1109,1155,1204,1258,1317,1381
 C:000366  05AC05FA065006B1        dc.w    1452,1530,1616,1713,1822,1945,2085,2247
 C:000376  09840A630B6E0CB5        dc.w    2436,2659,2926,3253,3661,4186,4885,5863
 C:000386  1CA32630394A7297        dc.w    7331,9776,14666,29335,32767
```

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0175178

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0175178

Readonly Trig Tables
Sine Table

```
C:000390                          sine_tbl: equ    *        * sine of 0..90 degrees by 1/2 Binary(15,15)
C:000390  0000011E023C035A          dc.w    0,286,572,858,1144,1429,1715,2000
C:0003A0  06EE0A0B0B280C45          dc.w    2286,2571,2856,3141,3425,3709,3993,4277
C:0003B0  11D012EB14061520          dc.w    4560,4843,5126,5408,5690,5971,6252,6533
C:0003C0  1A9D1BB41CCB1DE2          dc.w    6813,7092,7371,7650,7927,8204,8481,8757
C:0003D0  2348245B256C267E          dc.w    9032,9307,9580,9854,10126,10397,10668,10938
C:0003E0  2BC72CD42DDF2EEA          dc.w    11207,11476,11743,12010,12275,12540,12803,13066
C:0003F0  341035153618371B          dc.w    13328,13589,13848,14107,14365,14621,14876,15131
C:000400  3C183D143E0E3F08          dc.w    15384,15636,15886,16136,16384,16631,16877,17121
C:000410  43D444C6458746A6          dc.w    17364,17606,17847,18086,18324,18560,18795,19028
C:000420  4B3D4C234D084DEC          dc.w    19261,19491,19720,19948,20174,20399,20622,20843
C:000430  5247532153FA54D1          dc.w    21063,21281,21498,21713,21926,22138,22348,22556
C:000440  58EB59B75A825B4C          dc.w    22763,22967,23170,23372,23571,23769,23965,24159
C:000450  5F1F5FDE609A6155          dc.w    24351,24542,24730,24917,25102,25285,25466,25645
C:000460  64DE658D663A66E5          dc.w    25822,25997,26170,26341,26510,26677,26842,27005
C:000470  6A1E6ABD6B5A6BF4          dc.w    27166,27325,27482,27636,27789,27939,28088,28234
C:000480  6EDA6F686FF4707D          dc.w    28378,28520,28660,28797,28932,29066,29197,29325
C:000490  730C73887402747A          dc.w    29452,29576,29698,29818,29935,30050,30163,30274
C:0004A0  76AE77187780 77E5         dc.w    30382,30488,30592,30693,30792,30888,30983,31075
C:0004B0  79BC7A137A687ABB          dc.w    31164,31251,31336,31419,31499,31576,31651,31724
C:0004C0  7C337C777CB87CF7          dc.w    31795,31863,31928,31991,32052,32110,32166,32219
C:0004D0  7E0E7E3F7E6D7E98          dc.w    32270,32319,32365,32408,32449,32488,32524,32557
C:0004E0  7F4C7F697F837F9B          dc.w    32588,32617,32643,32667,32688,32707,32723,32737
C:0004F0  7FEC7FF57FFB7FFF          dc.w    32748,32757,32763,32767,32767

C:0004FA                          xi_tbl: equ     *        * (1+abs(cos(theta)))*sin(theta)/2 0..45 by 1/2
C:0004FA  0000011E023C035A          dc.w    0,286,572,858,1143,1429,1714,1999
C:00050A  08EB0A070B220C3D          dc.w    2283,2567,2850,3133,3416,3698,3979,4259
C:00051A  11BA12D113E614FB          dc.w    4538,4817,5094,5371,5647,5921,6195,6467
C:00052A  1A521B601C6D1D78          dc.w    6738,7008,7277,7544,7810,8074,8336,8598
C:00053A  2299239B249B259A          dc.w    8857,9115,9371,9626,9878,10129,10378,10624
C:00054A  2A752B682C592D48          dc.w    10869,11112,11353,11592,11828,12063,12295,12524
C:00055A  31D932B13390346C          dc.w    12752,12977,13200,13420,13638,13853,14066,14276
C:00056A  389339603A2A3AF2          dc.w    14483,14688,14890,15090,15286,15480,15671,15860
C:00057A  3EAD3F64401740C8          dc.w    16045,16228,16407,16584,16757,16928,17095,17260
C:00058A  440D44AC454745DF          dc.w    17421,17580,17735,17887,18036,18181,18324,18463
C:00059A  48A7492C49AD4A2B          dc.w    18599,18732,18861,18987,19110,19230,19346,19459
C:0005AA  4C704CDA4D41              dc.w    19568,19674,19777

C:0005B0                          total_tables:   set      *
                                          end
```

CLAIMS:

1. A method of encoding data on an encodable medium, representing knots on an outline defined relative to a coordinate plane, and for decoding said encoding data for use in a display process to produce images of said outline represented by said encoded data, the method comprising the steps of:

a) selecting sets of coordinates on said outline, to represent said knots,
b) establishing a successive order of said knots,
c) encoding said knots on an encodable medium in a data order indicative of said knot order, said step c) of encoding including encoding a complete information set of data providing a control code indicative at least one of i) the coordinate locations of said knots, ii) a knot's direction relative to others of said knots, iii) a predetermined shape of said outline between a pair of said knots, iv) data indicative of the shape of said outline at a knot, and v) providing data indicative of the coordinate distances between adjacent knots,
d) decoding said complete information sets in a decoding order related to said data order,
e) responsive to said complete information sets being indicative of the coordinate distances between adjacent knots, producing an image of a smooth continuous curved outline or a straight line between said adjacent knots or,
f) responsive to said complete information sets being indicative of a control code, producing

an image of a smooth continuous curved outline or a straight line according to said coordinate locations of said knots relative to adjacent knots in said successive knot order or producing an image of said outline being smooth at respective knots or being sharp and forming cusps at respective knots.

2. A method as in claim 1, whrein said step e) includes the step g) of evaluating the coordinate distance and the interknot angle between adjacent knots, comparing said evaluated coordinate distance of interknot angle to a predetermined coordinate distance or to a predetermined interknot angle and, producing a straight line between respective adjacent knots in response to said comparison to said predetermined coordinate distance or to said predetermined interknot angle.

3. A method as in claim 2, wherein said step g) includes the step of producing a straight line in response to said comparison indicating a default condition when said coordinate distance or said interknot angle is greater than said predetermined coordinate distance or interknot angle respectively.

4. A method as in claim 1, wherein said step f) of producing a straight line includes the step h) of linear interpolation between first and second knot end points, to produce coordinates on a straight line outline, and where said coordinates are located on a coordinate system having a first

coordinate direction and second coordinate direction and encoded in a machine, readable data words of a radix "r", corresponding to the order and value of designated positions in said data words, comprising the steps of:

i) encoding a first data word of "N" positions corresponding to the distance between the said first and second knot end points in said first coordinate direction and placing said first data word into a first machine location,

ii) encoding a second data word of "M" bits corresponding to the distance between said first and second knot end points in said second coordinate direction and placing said second data word into a second machine location,

iii) determining the number of available positions, between the most significant position of said first data word and the most significant position of said first machine location, available for shifting said first data word in a first direction of the most significant positions of said first machine location,

iv) shifting said first data word by a maximum number of positions, equal to said number of available positions in said first direction and the number of positions corresponding to the number of significant positions used to encode said second data word, and increasing the scale of said first data word by a scale factor related to the number of said positions shifted,

v) deriving a third data word indicative of said second data word in said second machine location divided into said first data word shifted according to step d),

vi) encoding data words indicative of the coordinate of said straight line in said second coordinate direction,

vii for respective ones of said data words encoded according to step vi), encoding a multiple of said third data word, which are related to a respective coordinate in said first coordinate direction, on said straight line,

viii reducing the scale of said multiples of said third data words produced in step vii) to the scale of the first data word of step i), prior to said shifting of step iv), and

ix encoding said third data words produced in step viii) with respective coordinates in said second coordinate direction to produce said coordinates on said straight line.

5. A method as in claim 4, wherein said step viii) of reducing the scale includes the step x) of truncating.

6. A method as in claim 4, wherein said step viii) of reducing the scale includes the step xi) of rounding.

7. A method as in claim 5, wherein said step x) of truncating includes the step xii) of shifting said data words of step vii) by the number of positions shifted in step iv).

8. A method as in claim 6, wherein said step xi) includes the step xiii) of shifting said data words

of step vii) by the number of positions shifted in step iv), less one position, to reduce the scale of said words, and adding a data word corresponding to a rounding value, to said respective data words, and shifting said respective data words an additional position to round said data words to the scale of the first data word of step i), prior to said shifting of step iv).

9. A method as in claim 2, wherein said steps e) or f) of producing a smooth continuous curve includes the step i) of generating a series of signals representing nodes on a locus of a curve partially defined by a set of related knots, encoded as data, with said knots defining the end points of respective segments of said curve locus and with said knots being in a successive order in relation to said locus, and for encoding said node signals as data for use when representing said curve segments in a separate additional process responsive to the shape of said curve locus, as represented by said encoded node signals, comprising the steps of:

i) for a first knot, (Z_a), representing a first end point of a first curve segment, deriving a first angle, indicative of the average of the interknot angles between said first knot (Z_a), and selected related knots, and encoding as data, signals indicative of said first angle,

ii) at a second of said knots (Z_b), representing a second end point of said first curve segment, establishing a second angle for said first curve segment, and encoding as data, signals indicative of said second angle,

iii) compiling data in a compiler according to a cubic parametric polynomial relationship between a parameter "t", said knots and angles at said end points of a said curve segment and the locus of said curve segment,

iv) the value for parameter "t" falling within a range of value "R",

v) applying said signals indicative of said locations of said first and second knots of said first curve segment, to said compiler,

vi) applying said signals indicative of the said first and second angles of said first curve segment to said compiler,

vii) applying a signal indicative of a distinct selected value of said parameter "t" within said range "R", to said compiler to derive a signal indicative of a respective node location on said first curve segment,

viii) repeating step vii) by applying signals indicative of additional distinct selected values of said parameter "t", within said range "R", to derive a plurality of signals indicative of respective node locations on said locus of said first curve segment for respective distinct selected values of said parameter "t", and

ix) encoding said signals derived in step vii) and viii), in a data base to represent said first curve segment.

10. A method as in claim 9, including the step x) of repeating steps i) through ix) for at least a

second curve segment within said locus of said curve.

11. A method as in claim 9, wherein said compiler is in the Hermite form.

12. A method as in claim 1, wherein said step f) of producing an image of said outline forming a cusp at respective knots includes the step j) of encoding said control value as indicative of a cusp formed at a first knot, and wherein the exit angle (ϕ) of said outline at said firt knot is substantially the interknot angle (B) between a preceding knot in said knot order and said first knot, and the outline between said knot and said preceding knot is a straight line.

13. A method as in claim 1, wherein said step f) of producing a smooth outline at a knot includes the step k) of encoding said control code value as indicative of a smooth outline at a first knot, and wherein the entrance angle (ϕ) of said outline at said first knot is substantially the interknot angle (B) between a preceding knot and said first knot, and said outline betweeen said preceding knot at said first knot is a straight line, and said outline between said first knot and a succeeding knot is a smooth continuous curve.

14. A method as in claim 1, wherein said step f) of producing a smooth outline at a first knot includes the step l) of encoding said control code value as indicative of a smooth knot outline at a first knot, and wherein the exit angle (ϕ) of said outline is substantially the interknot angle between said first knot and a successive knot, and said outline between said first knot and said

successive knot is a straight line, and said outline between said first knot and a preceding knot is a smooth continuous curve.

15. A method as in claim 1, wherein said step f) of producing a cusp at first knot includes the step m) of encoding said control code value as indicative of a cusp at a first knot, and wherein said outline is a smooth continuous curve between said first knot and a successive knot, and the entrance angle (θ) of said smooth continuous curve outline at said first knot is substantially the exit angle (ϕ) of said outline at said successive knot, with respect to the interknot angle (B) between said first knot and said successive knot, and said outline between said first knot and a preceding knot is a straight line.

16. A method as in claim 1, wherein step f) of producing a cusp at a first knot includes the step n) of encoding said control code value indicative of a cusp at a first knot, wherein said outline is a smooth continuous curve between said first knot and a preceding knot, and a straight line between said first knot and a succeeding knot, and the exit angle (ϕ) of said smooth continuous outline at said first knot is substantially that of the entrance angle (θ) of said outline at said preceding knot, with respect to the interknot angle (B) between said preceding knot and said first knot.

17. A method of encoding data on an encodable medium, representing knots on an outline loop defined relative to a coordinate plane, for producing a display image of said outline, and decoding

responsive to the interrelationship of said knots on said outline loop, and imaging said outline loop with imaging means responsive to said decoded data, the method comprising the steps of:

a) selecting sets of coordinates on said outline loop, to represent said knots,
b) establishing a successive order of said knots,
c) encoding on an encodable medium, said knots in a data order indicative of said knot order, said step c), of encoding including the step d), of encoding a complete information set of data indicative of the coordinate distances and interknot angles between adjacent knots,
e) comparing the relative positions of successive knots to at least a first interknot criterion,
f) responsive to said step e), of comparing, i) producing a first indication that a set of said successive knots is within said criterion, or ii) producing a second indication that a set of said successive knots is outside said criterion, and
g) i) responsive to said first indication, imaging, with imaging means, said outline loop in the form of a smooth continuous curve, or ii) responsive to said second indication, imaging said outline loop in the form of a straight line, between said set of successive knots.

18. A method as in claim 17, wherein said interknot criterion is a predetermined distance between said knots or a predetermined interknot angle between

said knots and said step f), i) of producing said first indication, produces said first indication in response to said interknot distance between said knots, or said interknot angle between said knots being less than a predetermined interknot distance or the interknot angle respectively, and said step f), ii) of producing said second indication produces said second indication in response to the interknot distance or said interknot angle being greater than a predetermined interknot distance or interknot angle, respectively.

19. A method as in claim 18, wherein said step g), i) includes the step h), of generating a series of signals representing nodes on a outline loop curve partially defined by a set of set successive knots, with said knots defining the end points of said curve outline loop, and encoding said node signals as data for use when representing said curve outline loop, and

i) for a first knot of said successive knots, (Z_a), representing a first end point of said curve outline loop, deriving a first angle, indicative of the average of the interknot angles between said first knot (Z_a) and selected related knots, and encoding as data, signals indicative of said first angle,

ii) at a second of said successive knots (Z_b), representing a second end point of said first curve outline loop, establishing a second angle for said first curve outline loop and encoding as data, signals indicative of said second angle,

iii) compiling data in a compiler according to a cubic parametric polynomial relationship between a parameter "t", said knots and angles at said end points of a said curve segment and the locus of a said curve segment,

iv) maintaining parameter "t" within a range "R" of values for said parameter "t",

v) applying said signals indicative of said locations of said first and second knots of said first curve outline loop, to said compiler,

vi) applying said signals indicative of the said first and second angles of said first curve outline loop to said compiler,

vii) applying a signal indicative of a distinct selected value of said parameter "t" within said range "R", to said compiler to derive a signal indicative of a respective node location on said first curve outline loop,

viii) repeating step vi) by applying signals indicative of additional distinct selected values of said parameter "t", within said range "R", to derive a plurality of signals indicative of respective node locations on said locus of said first curve segment for respective distinct selected values of said parameter "t", and

ix) encoding said signals derived in step vii), and viii), in a data base to represent said first curve segment.

20. A method as in claim 19, including the step i), of repeating steps h), i) through h), ix) for at least

a second curve outline loop.

21. A method as in claim 19, wherein said compiler is in the Hermite form.

22. A method as in claim 19, wherein step h), i) and h), ii) includes the step h) xi) of referencing said first and second angles of said first curve segment, to a first of said interknot angles between said second knot (Z_b), and said first knot (Z_a).

23. A method as in claim 18, wherein said step g), ii) includes the step l) of linear interpolation of coordinate points between said successive knots to produce coordinates on a straight line outline, and where said coordinates are located on a coordinate system having a first coordinate direction and second coordinate direction, and encoded in a machine, readable data words of a radix "r", corresponding to the order and value of designated positions in said data words, comprising the steps of:

i) encoding a first data word of "N" positions corresponding to the distance between the first and second successive knots in said first coordinate direction and placing said first data word into a first machine location,

ii) encoding a second data word of "M" bits corresponding to the distance between said first and second successive knots in said second coordinate direction and placing said second data word into a second machine location,

iii) determining the number of available positions, between the most significant position of said first data word and the most significant position of said first machine location, available for shifting said first data word in a first direction of the most significant positions of said first machine location,

iv) shifting said first data word by a maximum number of positions, equal to the said number of available positions in said first direction and the number of positions corresponding to the number of significant positions used to encode said second data word, and increasing the scale of said first data word by a scale factor related to the number of said positions shifted,

v) deriving a third data word indicative of said second data word in said second machine location divided into said first data word shifted according to step d),

vi) encoding data words indicative of the coordinate of said straight line in said second coordinate direction,

vii) for respective ones of said data words encoded according to step f), encoding multiples of said third data word, which are related to a respective coordinate in said first first coordinate direction, on said straight line,

viii) reducing the scale of said multiples of said third data words produced in step vi), to the scale of the first data word of step i), prior to said shifting of step iv),

ix) encoding said third data words produced in step viii), with respective coordinates in said second coordinate direction to produce said coordinates on said straight line.

24. A method as in claim 23, wherein said step, viii), of reducing the scale includes the step, x) of truncating said data words of step vii).

25. A method as in claim 23 , wherein said step, viii), of reducing the scale, includes the step xi), of rounding said data words of step vii).

26. A method as in claim 24, whrein said step x), of truncating, includes the step xii), of shifting said data words of step vii), by the number of positions shifted in step iv).

27. A method as in claim 25, wherein said step xi), includes the step xiii), of shifting said data words of step vii), by the number of positions shifted in step iv), less one position, to reduce the scale of said words, and adding a data word corresponding to a rounding value, to said respective data words, and shifting said respective data words an additional position to round said data words to the scale of the first data word of step i), prior to said shifting of step iv).

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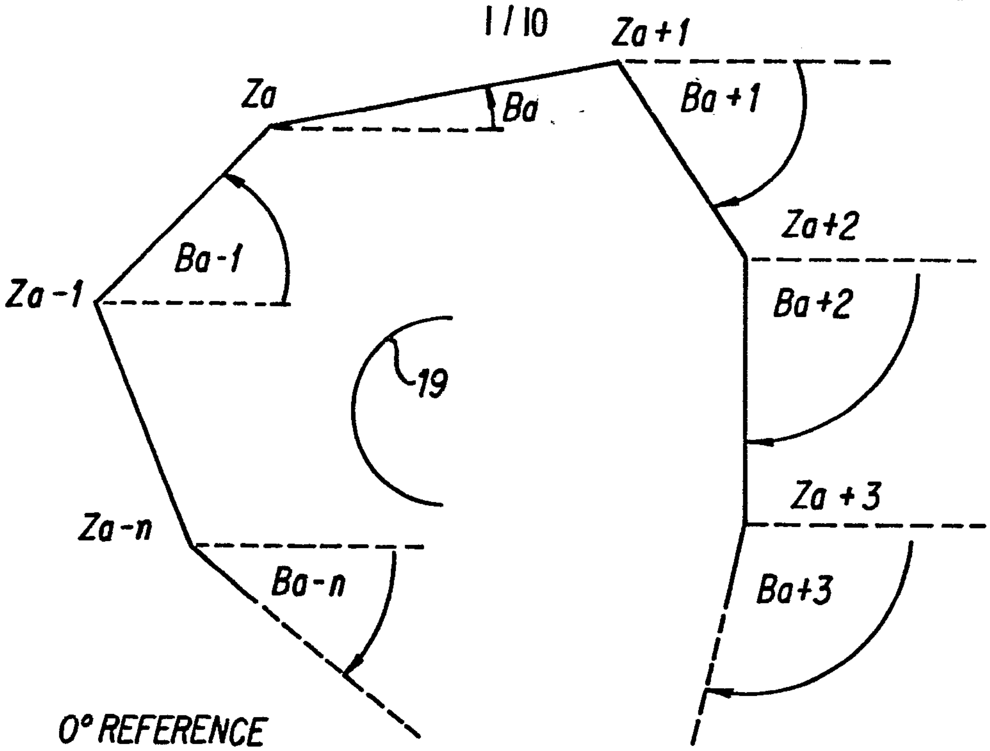


FIG. 1a

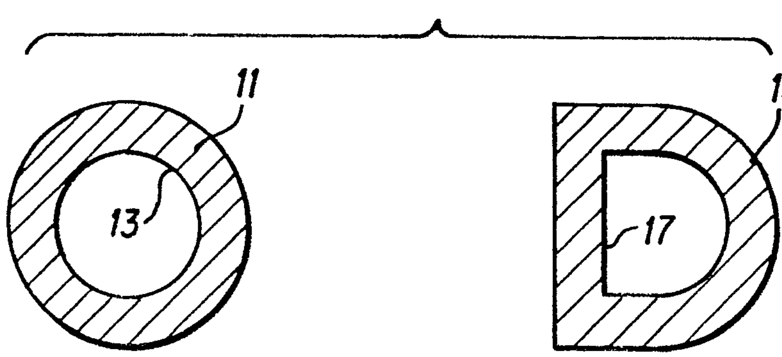


FIG. 1b

Allied Corporation
Application No. 85 110 750.8

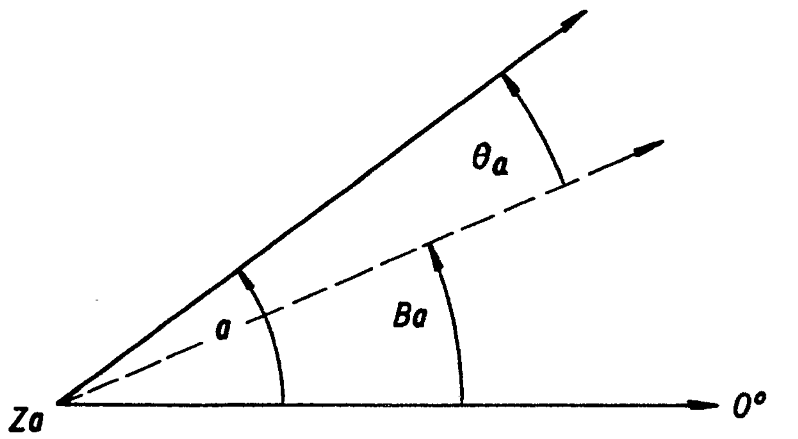


FIG. 1d

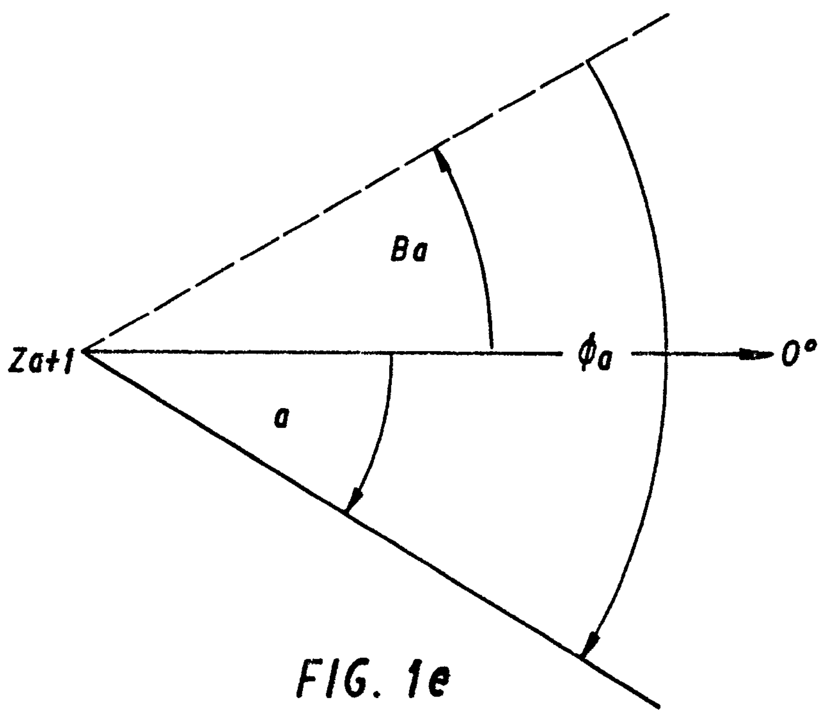


FIG. 1e

Allied Corporation
Application No. 85 110 750.8

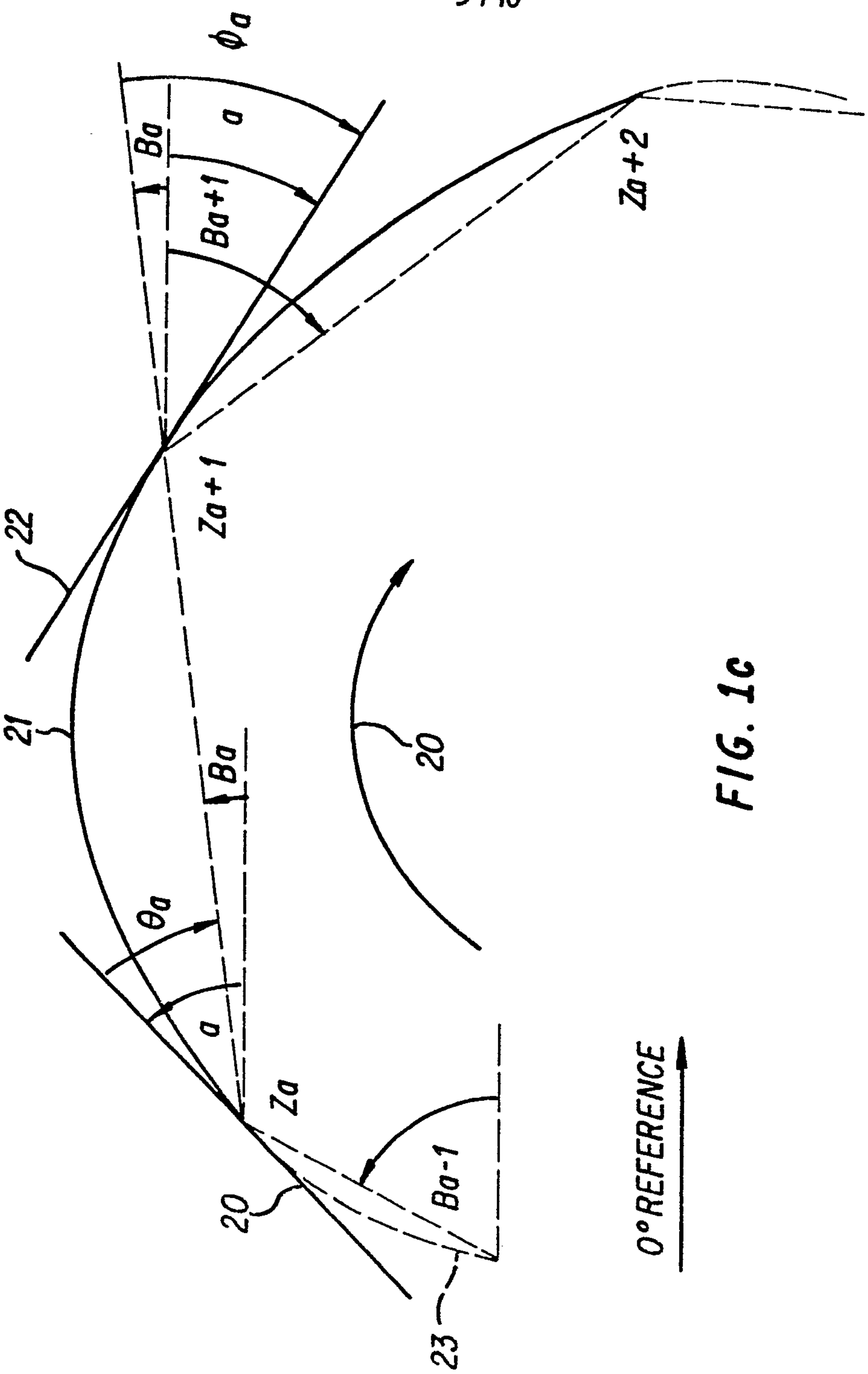


FIG. 1c

Allied Corporation
Application No. 85 110 750.8

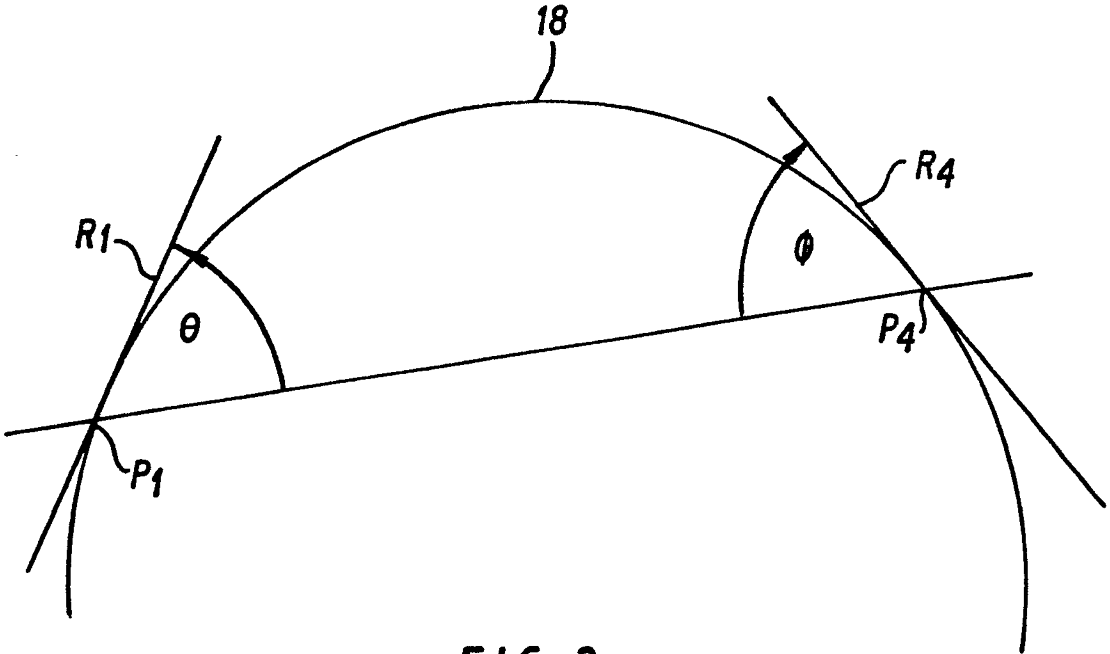


FIG. 2

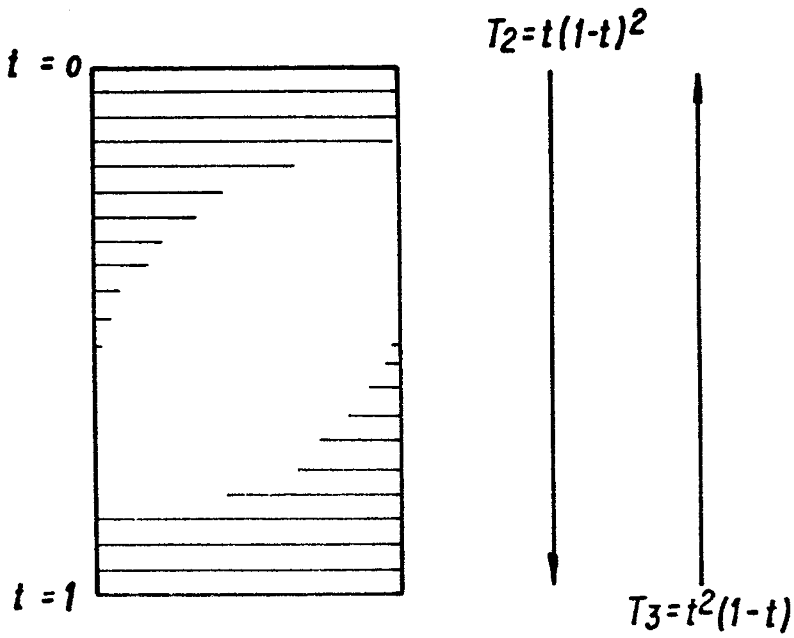
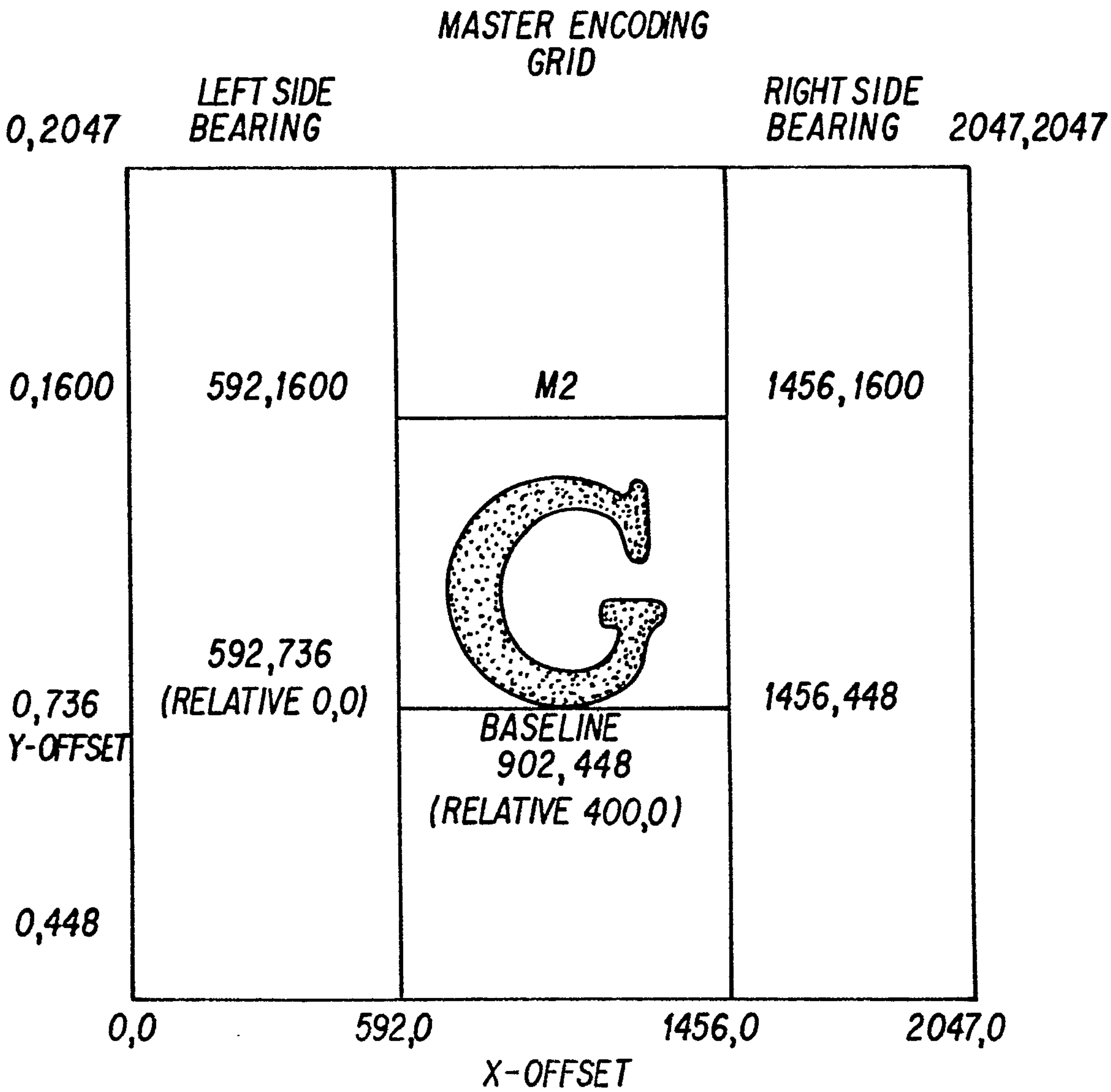


FIG. 4

Allied Corporation
Application No. 85 110 750.8


MASTER ENCODING GRID
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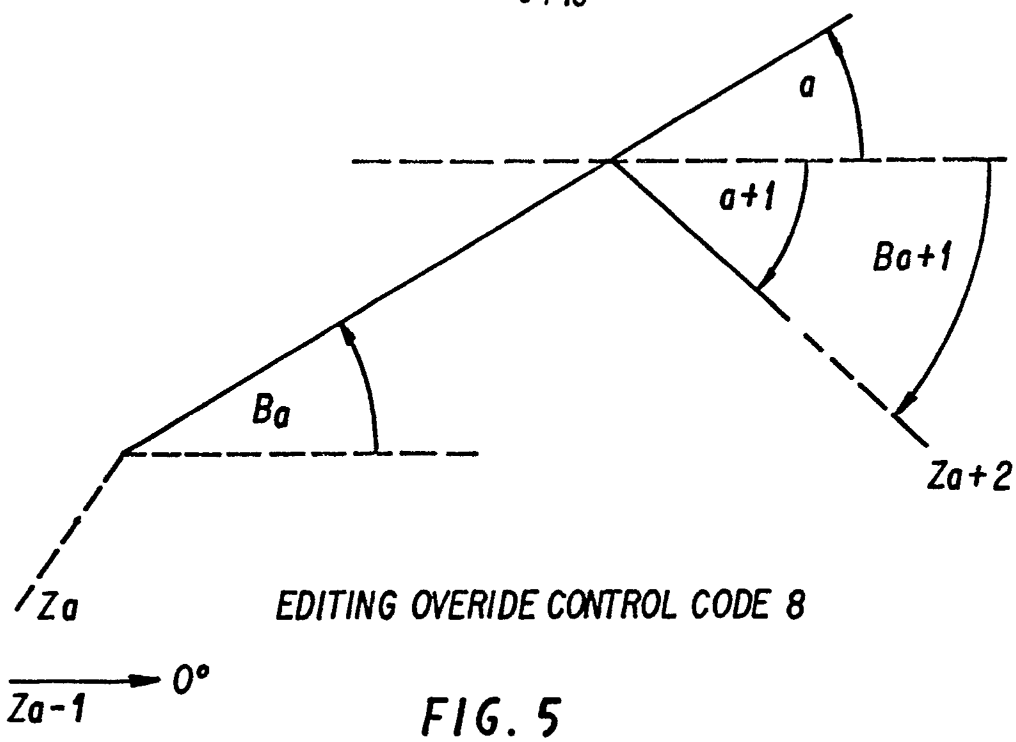
RIGHT SIDE BEARING
0,2047
2047,2047
0,1600
592,1600
M2
1456,1600
G
592,736
(RELATIVE 0,0)
0,736
Y-OFFSET
1456,448
BASELINE
902,448
(RELATIVE 400,0)
0,448
0,0
592,0
1456,0
2047,0
X-OFFSET

FIG. 3



EDITING OVERIDE CONTROL CODE 8

FIG. 5

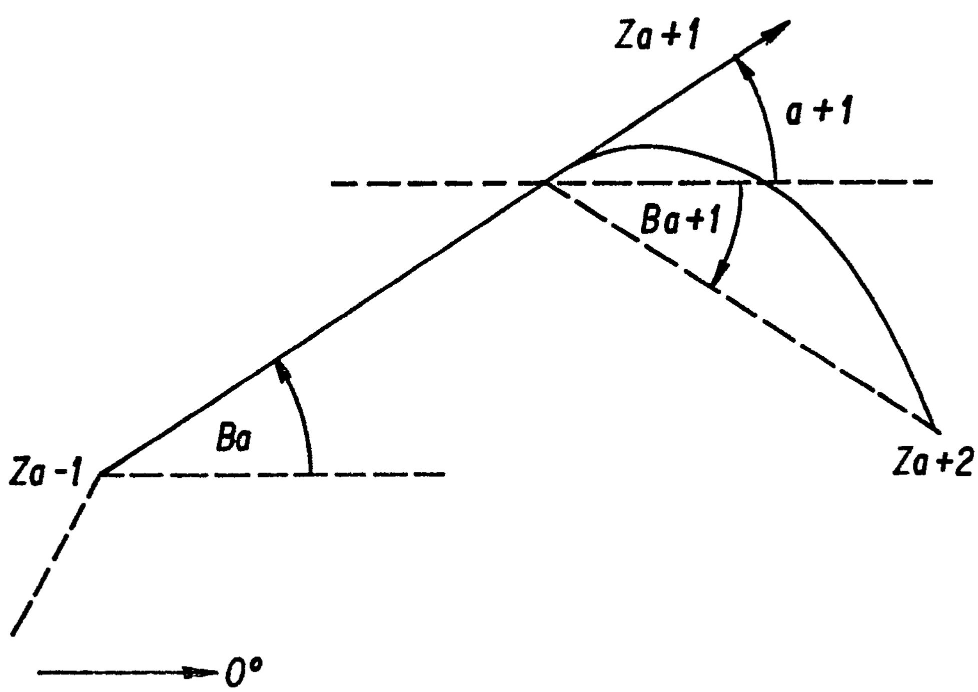


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FIG. 6a

Allied Corporation
Application No. 85 110 750.8

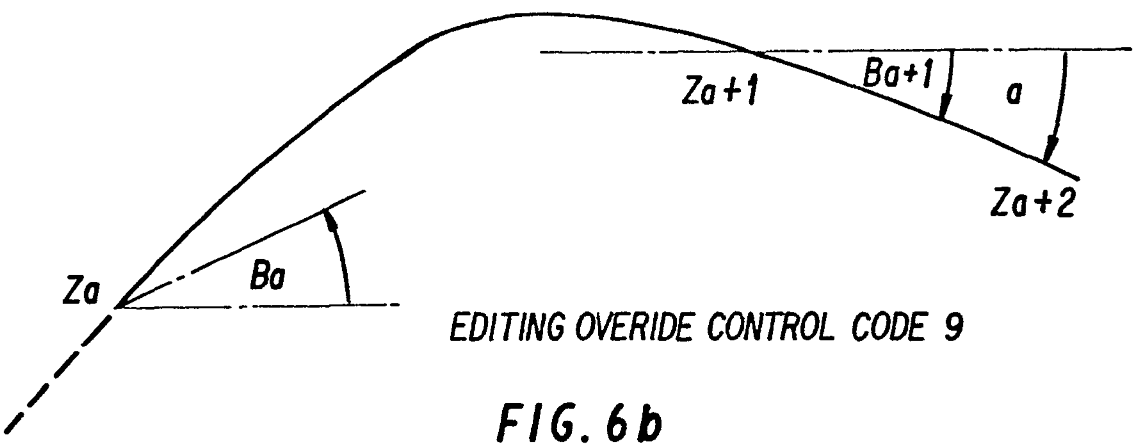

FIG. 6b

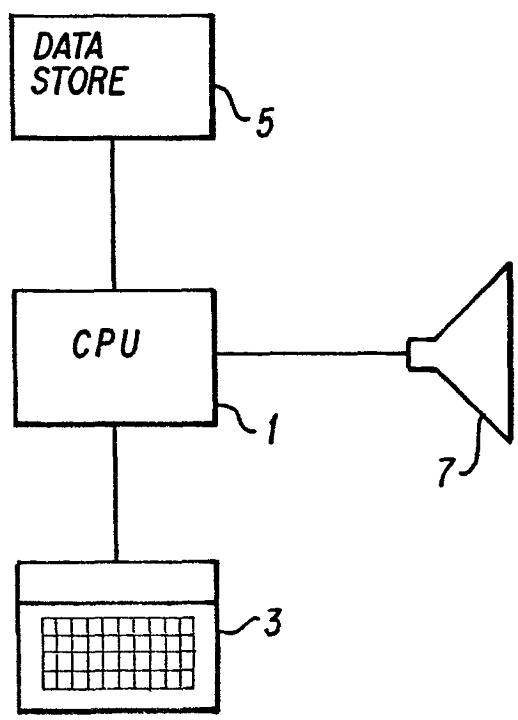

FIG. 10

Allied Corporation
Application No. 85 110 750.8

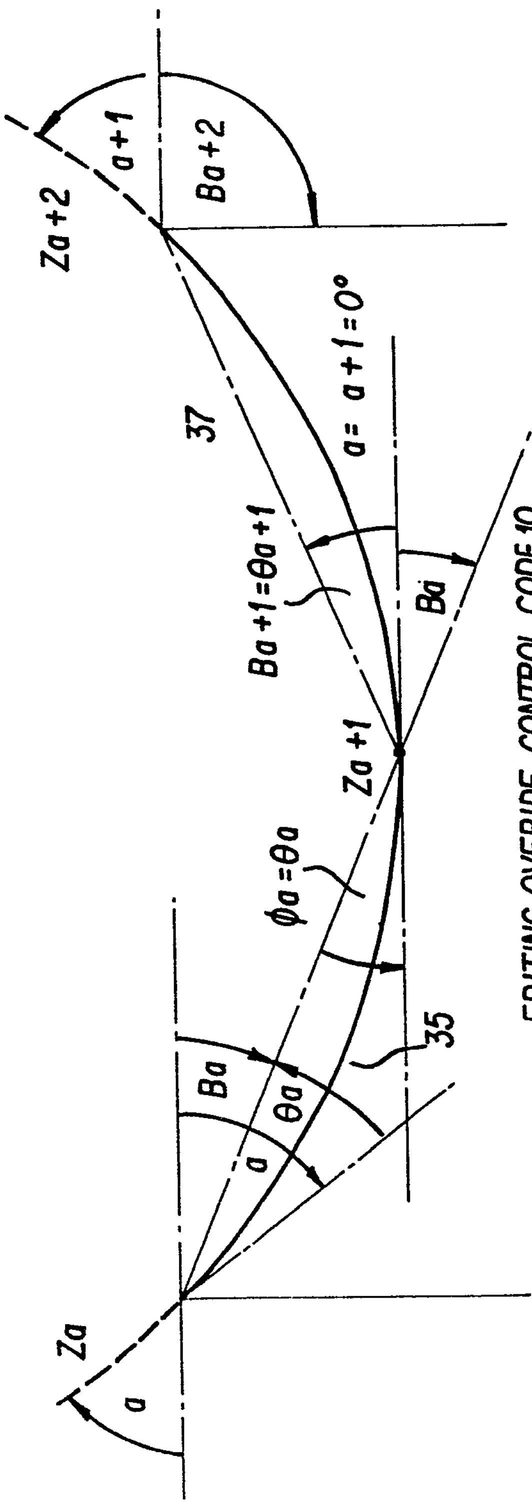

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FIG. 7a

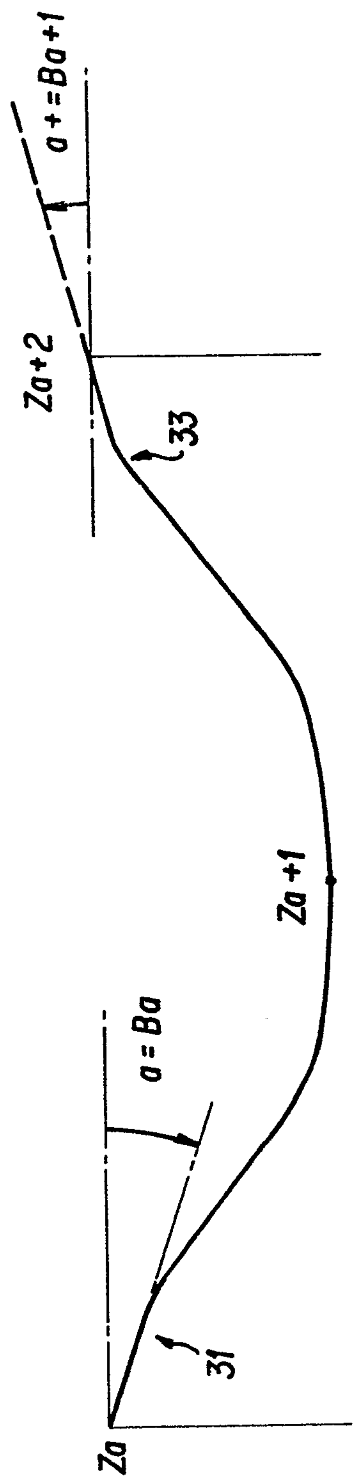

FIG.7b

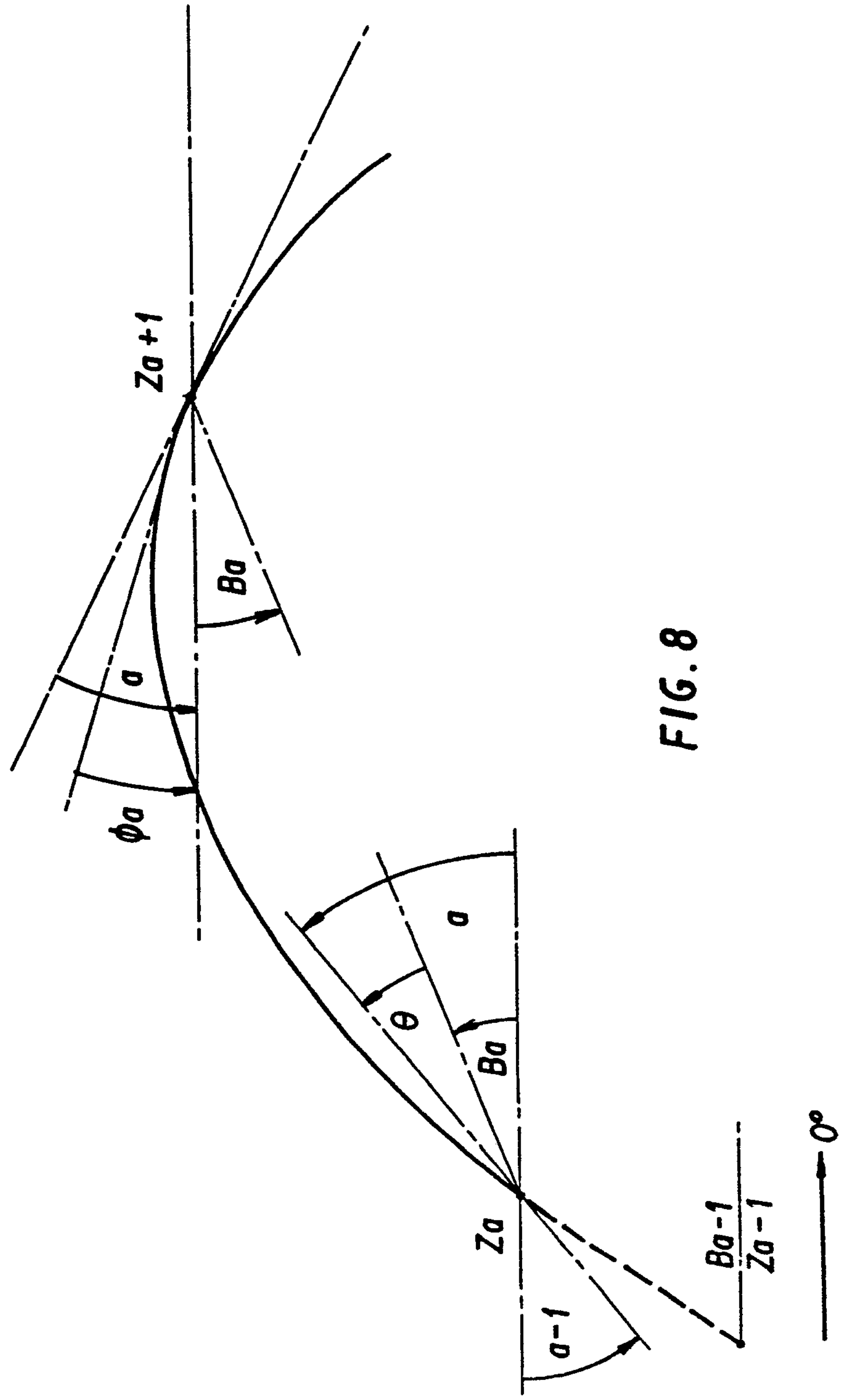

FIG. 8

Allied Corporation
Application No. 85 110 750.8

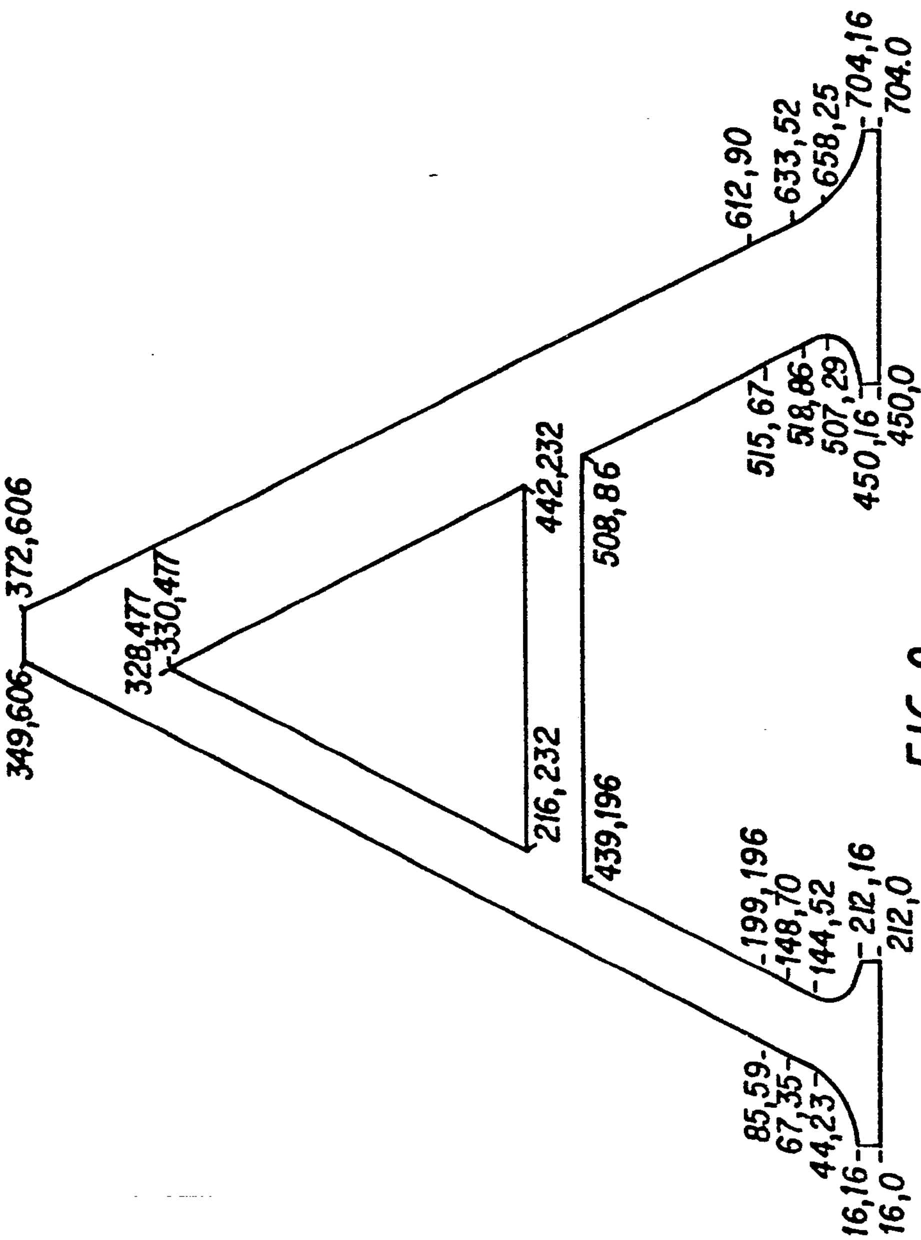

FIG. 9

Allied Corporation
Application No. 85 110 750.8