(19) **United States**

(12) **Patent Application Publication** (10) Pub. No.: US 2017/0193327 A1

Thompson et al. (43) **Pub. Date:** **Jul. 6, 2017**

(54) **KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS**

(71) Applicant: **HY-KO Products Company**, Northfield, OH (US)

(72) Inventors: **Chester O.D. Thompson**, Painesville, OH (US); **William R. Mutch**, North Ridgeville, OH (US); **Randall A. Porras**, North Olmsted, OH (US)

Publication Classification

(57) **ABSTRACT**

A key identification system is provided. The key identification system comprises a sensing device configured to extract bitting information from a master key, and a logic configured to analyze the image. The sensing device may be configured to capture information about the bittings of the master key, such as an image of the bittings. The logic analyzes information about the bittings of the master key and compares it with bitting characteristics of known key blanks to determine the likelihood of a match between the master key and a known key blank.
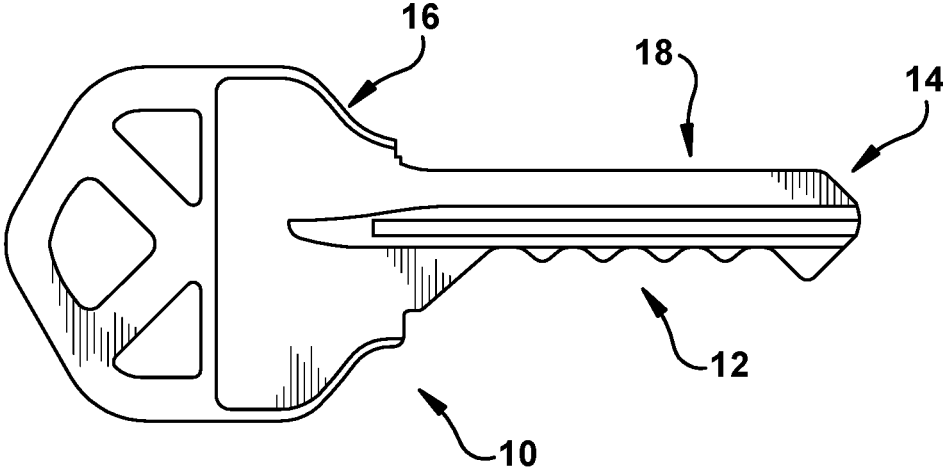
FIG. 1

FIG. 2

FIG. 3

FIG. 4

Test ProfileID

Scan Key

| Matches | Test Results |

SC1 Test FAILED

Depth Tolerance = +/- 6 thousandths
Flat Definition = Angle < 17 degrees

Space 231 - Fail
Avg Depth: 237   -7

Space 387 - Pass
Avg Depth: 281   -6

Space 543 - Pass
Avg Depth: 304   -1

Space 698 - Pass
Avg Depth: 237   -7

Space 855 - Pass
Avg Depth: 330   -5

855   698   543   387   231

ProfileID Name
SCI

Test
ProfileID

View Notes

Hide
Spaces

Hide
Depths

Save
Screenshot

Exit Page

FIG. 5

FIG. 6

KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 14/147,308, filed on Jan. 3, 2014, and entitled "KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS," which is a continuation of U.S. patent application Ser. No. 12/772,763 filed on May 3, 2010, and entitled "KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS," which claims the benefit of priority of U.S. Provisional Patent Application No. 61/215,122 filed on May 1, 2009, and entitled "KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS," and U.S. Provisional Patent Application No. 61/275,648 filed on Sep. 1, 2009, and entitled "KEY BLANK IDENTIFICATION SYSTEM WITH BITTING ANALYSIS," each of which are hereby incorporated by reference in their entirety.

FIELD OF ART

[0002] This invention relates generally to the field of systems for identifying objects and, more particularly to systems for utilizing a means for identifying key blanks that are functionally compatible with an unknown key.

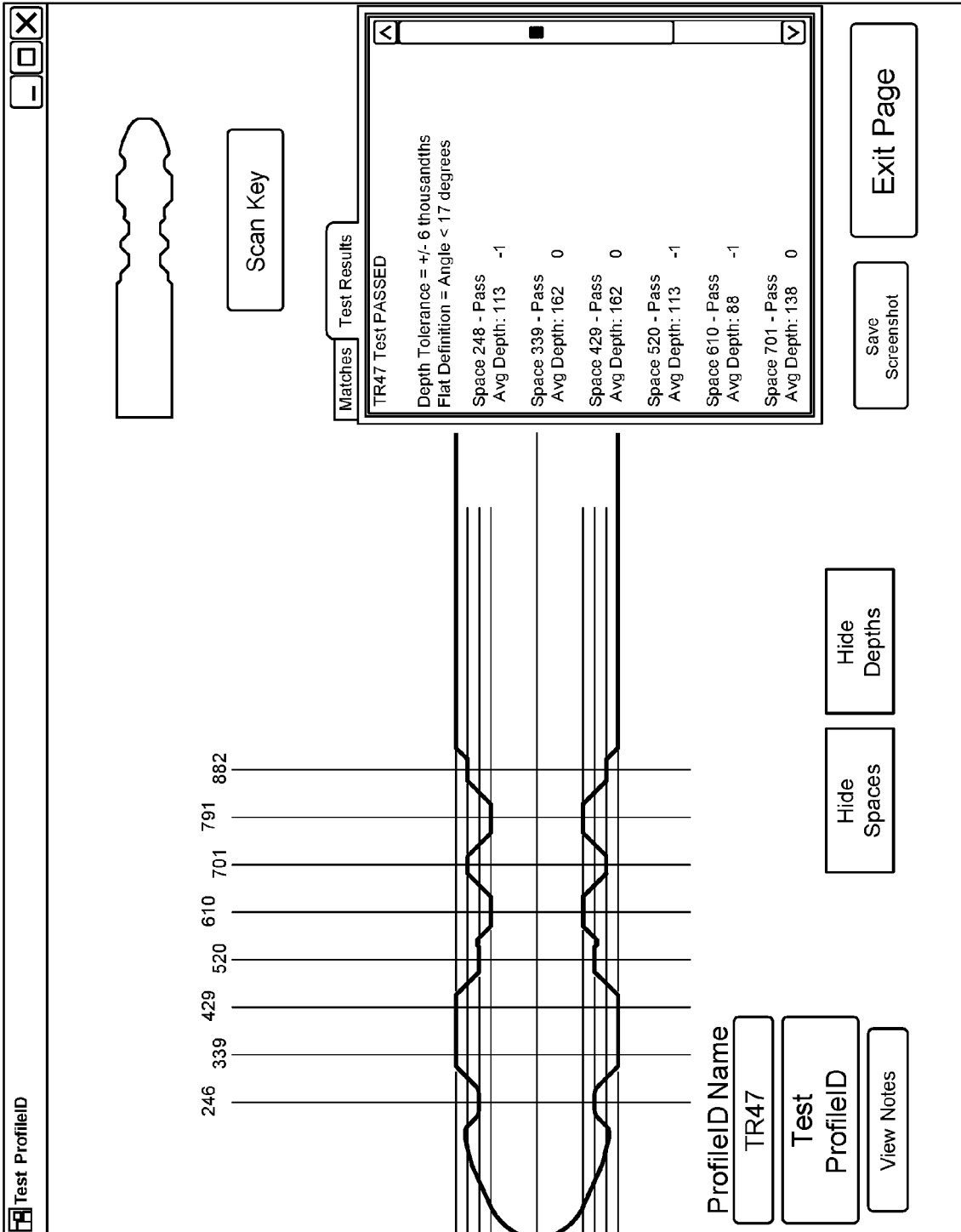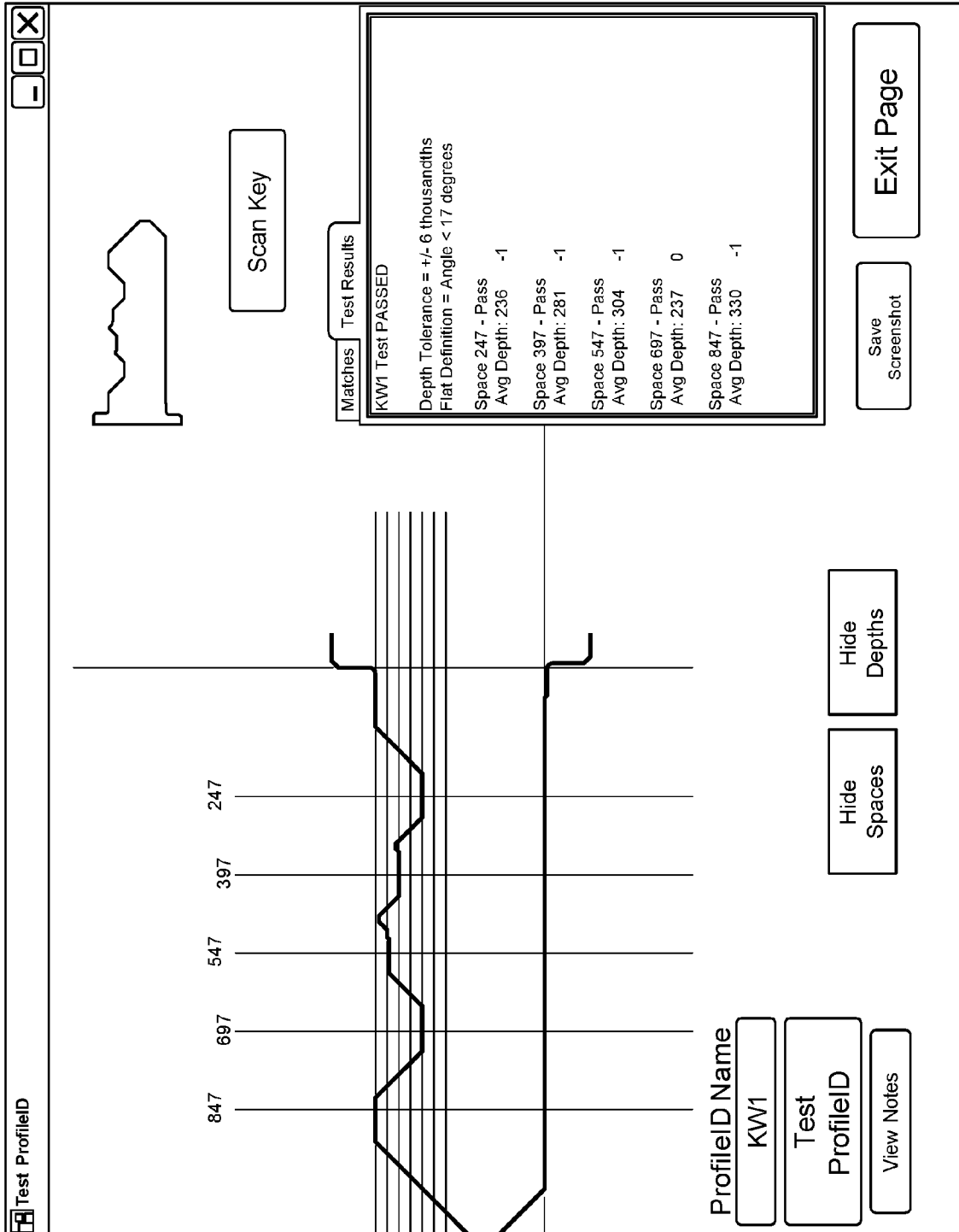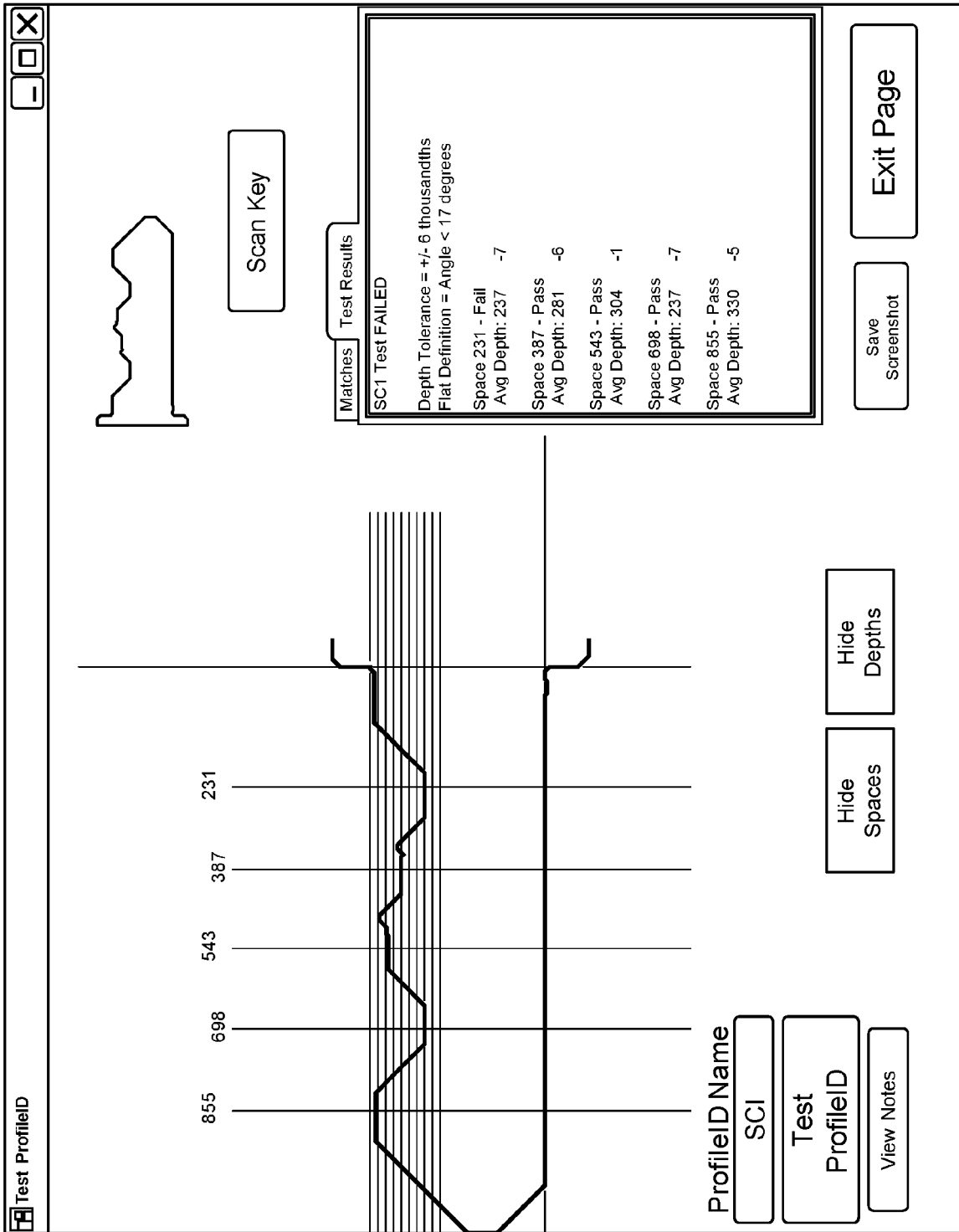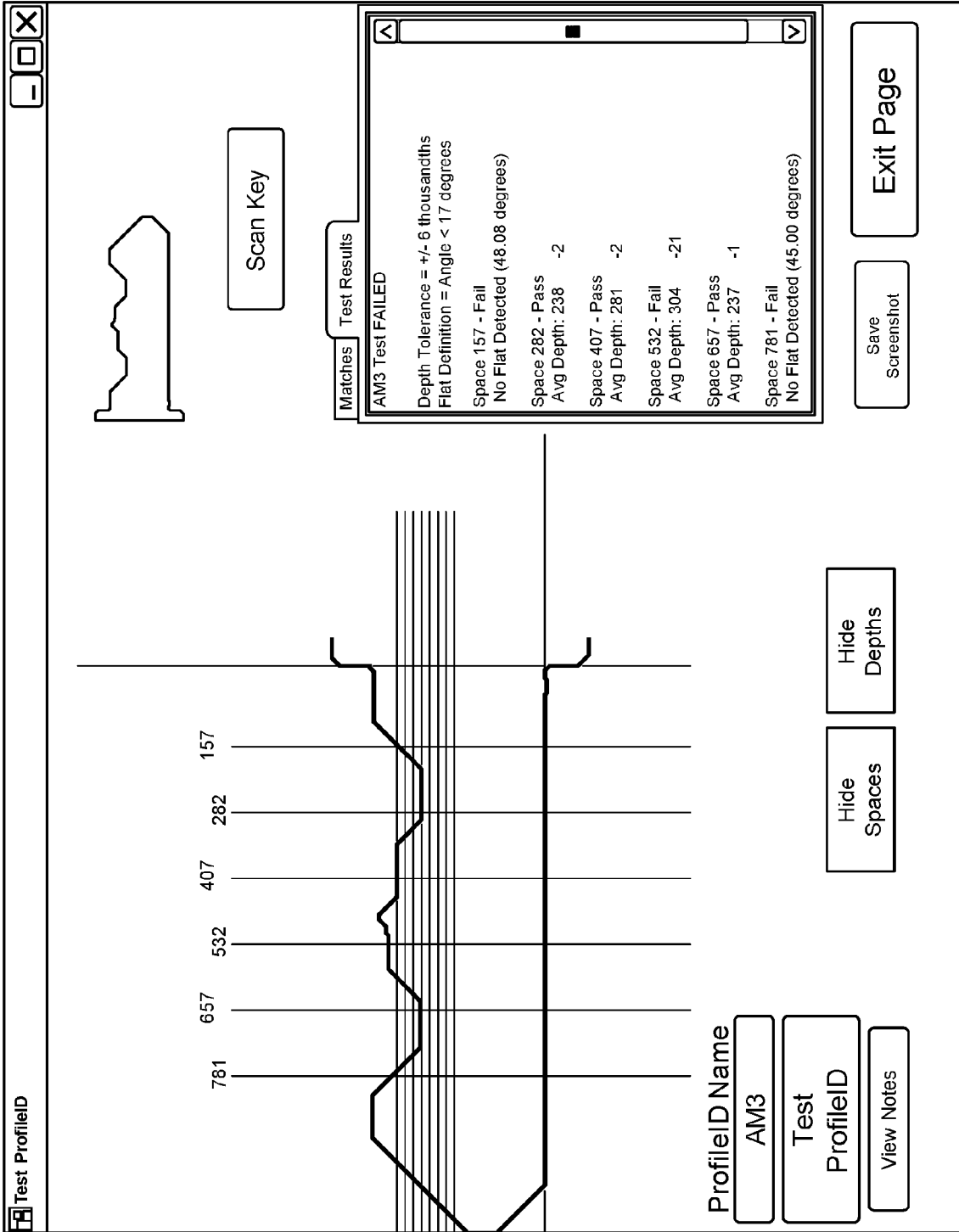## BACKGROUND OF THE INVENTION

[0003] The art of key replication is well known. Commonly, a key intended for duplication (the master key) is copied on to an appropriately identified key blank utilizing any number of different systems known in the art. The process of identifying an appropriate key blank to use when making copies of a key can be a difficult, tedious and time consuming affair. It is important that each master key be copied onto the proper key blank so as to prevent numerous adverse consequences caused by reproducing a master key onto an inappropriate key blank. However, choosing the correct key blank can be difficult even for experts in the field.

[0004] There are hundreds, if not thousands, of key blanks, and many blanks are not readily distinguished from others. Identifying the correct key blank for use in duplication involves selecting a blank from hundreds or even thousands of possibilities, where differences between key blanks may be very subtle. These hard-to-notice subtleties significantly increase the level of difficulty for all operators of such key replication systems, both inexperienced trainees and experts alike.

[0005] Once a key blank is chosen, it goes through a cutting process. The typical cutting process simply traces the profile of the master key onto the key blank, such that the key blank will exactly match (within the error limits and accuracy of the tracing machine) the original master key. Normally, a mechanically linked cutting wheel actually cuts into the key blank while it mimics the movement of the tracer as the tracer moves longitudinally along the profile of the master key. If the incorrect key blank is provided during this process, the key blank being formed into the duplicate key may not possess the correct longitudinal length, thereby causing a failure. When this type of failure occurs, the entire process of selecting a key blank for replication and then mechanically cutting the key must begin again. Worse still,

if the blank has the proper length but does not possess the appropriate thickness, contour, groove or other traits, the failure may not be discovered until the key is actually inserted into the lock.

[0006] Businesses that offer key cutting services are often times not staffed by experienced locksmiths. Instead, employees are usually trained to "eyeball" what is thought to be the correct blank and then cut a duplicate key. Such informal and imprecise key blank identification invariably increases the rate of failures for the duplication process. These failures often occur at the expense of the industry and to the extreme dismay of the key holder. Therefore, the industry would welcome an easy-to-use key blank identification system that increases the accuracy and efficiency of key replication.

[0007] Not surprisingly, numerous attempts have been made to improve identification systems and/or key replication systems. Many of these improvements include imaging systems designed to determine the proper key blank based on physical parameters of the key to be copied, such as length, shape, and groove characteristics.

[0008] While many of these systems provide useful improvements for determining a proper key blank, they still suffer from various deficiencies. Specifically, many of these systems compare scanned data from a master key with data of known key blanks. However, in some instances the scanned key parameters and the key blank data are insufficient to determine the proper key blank. In such cases, additional information about the master key and the key blank would be useful in narrowing the field of prospective key blanks. Accordingly, an improved system and method for determining a key blank is needed.

SUMMARY

[0009] A key identification system is provided. The key identification system comprises a sensing device configured to determine information and characteristics of a master key, and a logic to analyze the information and characteristics of the master key. The sensing device may be configured to capture information about the bittings of the master key. The logic analyzes information about the bittings and compares it with bitting characteristics of known key blanks to determine the likelihood of a match between the master key and the known key blanks.

[0010] In an embodiment, the system configured to extract bitting information may comprise an imaging system, such as a camera or other imaging device. The camera may capture an image, such as a digital image, of the bittings of the master key to be analyzed by the logic.

DESCRIPTION OF THE DRAWINGS

[0011] Objects and advantages together with the operation of the invention may be better understood by reference to the following detailed description taken in connection with the following illustrations, wherein:

[0012] FIG. 1. illustrates a master key.

[0013] FIG. 2. illustrates an embodiment of the key ID system.

[0014] FIG. 3 illustrates an example comparison chart between a TR47 master key and TR47 key data.

[0015] FIG. 4 illustrates an example comparison chart between a KW1 master key and KW1 key data

[0016] FIG. **5** illustrates an example comparison chart between a KW1 master key and SC1 key data.

[0017] FIG. **6** illustrates an example comparison chart between a KW1 master key and AM3 key data.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Reference will now be made in detail to exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. It is to be understood that other embodiments may be utilized and structural and functional changes may be made without departing from the respective scope of the present invention.

[0019] A system for identifying a key blank ("key ID system") and method for identifying a key blank are provided. The key ID system analyzes a master key to be duplicated, such as a house key, car key or other key, and determines the appropriate key blank to be used. The system and method described herein may be used independently to determine a proper key blank, or may be used in conjunction with other systems to narrow the field of prospective key blanks. Moreover, it will be understood that existing key identification systems may be modified or retrofitted to implement some or all features described herein.

[0020] With reference to FIG. **1**, a master key **10** is depicted. The master key **10** may include standard key features such as a head **16** and a blade **18**. The blade **18** may connect at one end to the head **16** with the tip **14** at the opposing end. The master key **10** may include teeth or bittings **12** cut into the blade. The bittings **12** consist of notches cut in the blade **18** to interface with the tumblers of a corresponding lock. The bittings **12** must match up with the lock's unique tumbler configuration in order to activate and turn the lock.

[0021] The key ID system may analyze the master key **10** to determine certain physical characteristics of the key **10**. Based on these characteristics, the key ID system may then determine the proper key blank to be used to duplicate the master key **10**. For example, the key ID system may include a sensing device or system to extract bittings information from a master key **10**. The sensing system may sense and capture parameters of the bittings **12**. The sensing system may include any mechanical, electronic or optical sensors, sensors, imaging devices or other tools known in the art for extracting physical characteristics of a key or similar object.

[0022] In an embodiment, the sensing system for extracting bittings information from the master key **10** includes an imaging system to scan and analyze the physical characteristics of the master key **10**. As is known in the art, the imaging system may be a laser imaging system, an optical imaging system, a photo imaging system, or any other imaging system known in the art. The imaging system may scan the master key or capture an image of the master key to determine characteristics of the key that are unique to a specific key blank. Further, it will be appreciated that other known methods or devices, such as electrical, mechanical, or optical sensors, may be used in place of or in conjunction with the imaging system to determine the traits and characteristics of the master key geometry.

[0023] In an embodiment illustrated in FIG. **2**, the imaging system includes one or more cameras **20** configured to capture an image, such as digital images, of the master key **10**. The camera **20** may specifically be positioned to capture an image of the blade **18** and bittings **12**. The camera **20** may be positioned perpendicular to the blade **18**. Alternatively, the camera **20** may positioned at an angle or at other position to capture the desired image

[0024] The imaging system may further include other components to aid in capturing images of the master key **10**, such as one or more lights **24** and mirrors. The lights **24** may be positioned to enhance the clarity and quality of the image recorded by the imaging system. For example, the light **24** may be positioned to provide backlighting for the key. The mirrors may be positioned to allow a camera in a first position to record an image of the key from a second position. The mirrors may further allow a single camera to record multiple images of the master key from different angles, thereby increasing the amount of information related to the master key recorded by a single camera

[0025] As illustrated in FIG. **2**, the image system may include one or more reflectors **26**. The reflector **26** may be positioned to direct light to a desired location. For example, as shown in FIG. **2**, a reflector may be positioned underneath the key **10** and facing the light **24**. The reflector **26** may be angled, such as tilted upwards, to direct light from the light **24** to the underside of the key **10**, thereby providing backlighting of the key **10**. It will be appreciated, however, that the light **24** and reflector **26** may be arranged in any configuration to optimize or clarify the image of the key **10**.

[0026] The key ID system may include a key holder **22** to hold the master key **10**. The key holder may be any device capable of holding or supporting a master key **10**. For example, as shown in FIG. **2**, the key holder **22** may comprise a lower support and an upper door to close onto the key **10**. The key holder may alternatively comprise a clamp, gripper, platform, suspension, or any other device configured to hold the master key **10**.

[0027] As described in further detail below, the key ID system may analyze characteristics of the master key's teeth or bittings **12**. Because the bittings **12** are configured to match up with the corresponding lock's unique tumbler configuration, various characteristics of the bittings **12** are often unique to certain types of key blanks. For example, certain key manufacturers may use distinct bitting patterns, or a set of unique bitting patterns, for their locks or for a group of locks. Additionally, certain types of keys, such as house keys or car keys, may use a different bittings configuration than other types of keys. By analyzing the master key bittings **12** and comparing them to bitting configurations used with known key blanks, the field of prospective matching key blanks may be greatly reduced.

[0028] The key ID system may include a logic to analyze bitting characteristic information captured by the key ID system. As used herein, the term "logic" includes but is not limited to a software, a firmware, an executable program, a hardware or hard-wired circuit, or combinations thereof. For example, based on a desired application or needs, a logic may include a software controlled microprocessor, discrete logic like an application specific integrated circuit (ASIC), an analog circuit, a digital circuit, a programmed logic device, a memory device containing instructions, or the like. Logic may include one or more gates, combinations of gates, or other circuit components. Logic may also be fully embodied as software. Where multiple logics are described, it may be possible to incorporate the multiple logics into one physical logic. Similarly, where a single logic is described, it may be possible to distribute that single logic between multiple physical logics.

3

[0029] The logic may be configured to determine a correlation or likelihood of a match between a known key blank and the master key **10**. For example, the logic may include a database to store key related information ("key data"). The key data may include characteristics of known key blanks, such as length, shape, bitting information, size, shape and location of key grooves, and other geometric and physical characteristics of known key blanks. The database may be integral with the logic, in communication with the logic, or remotely accessible to the logic. The database may associate key data with specific key blanks or with types or groups of key blanks. For example, the database may associate key data with specific key manufacturers or different types of keys such as house keys or car keys. The key ID system may access the database to compare scanned characteristics of the master key with the stored key data in the database. Key blanks that do not have characteristics consistent with those of the master key may be then ruled out as possible matches for the key blank. The key ID system may scan the master key **10** at one or more angles and compare the scanned data with stored key data.

[0030] In an embodiment, the database stores key data related to bittings used with known key blanks. Traditionally, key bittings are represented as a numeric bitting code that contains information as to how a key is to be cut by a locksmith. Often the bitting code is a series of integers (e.g. 372164) that may be translated or decoded from a key code chart or bitting code list. However, not all the information in the bitting code is necessary in order to determine unique properties of the bittings. Therefore, the database may store data related to known key bitting patterns other than numeric bitting codes. For example, the database may store measurements of bitting geometries used with known key blanks.

[0031] Stored bitting geometries may include bitting spacings, notch depths, blade width, and bitting flat width. Spacing data may relate to the location or spacing between of each bitting notch along the length of the key blade **18**. Spacing data may be measured from the center of each notch to a specific reference point, such as the tip **14** or shoulder of the blade **18**. Depth data may relate to the depth of each bitting notch and may be measured as the distance between a reference edge, such as the back side or center line of the blade **18**, and the notch surface. Blade width may relate to the width of the blade surface to be cut. Bitting flat width may relate to the width of each notch surface and may be measured as the distance across the bottom of the notch.

[0032] In an embodiment, the logic may determine bitting parameters of the master key **10** by analyzing an image captured by an imaging system. The bitting parameters may be compared to bitting data in the database to determine if the master key **10** matches a key blank or blanks in the database. As shown in FIGS. **3-6**, bitting parameters of the master key, such as spacing and depth, may be analyzed at various preselected points, such as at the bitting notches. The master key bitting parameters may then be compared to bitting data in the database. If the bitting parameters of the master key match the bitting data of a key blank in the database, then that key blank may be appropriate for duplicating the master key. For example, if each bitting depth of a master key **10** is very close to an allowable bitting depth for a given key blank, then the key blank may be a match. Likewise, if the bitting flat width and spacing of the bittings of a master key **10** are close to allowable bitting flat widths and spacings for a given key blank, then the key blank may

be a match. However, if the bitting data of the master key is not close to allowable data for a given key blank, then the given key blank or blanks may be ruled out as a possible match.

[0033] The database may associate bitting data with various key-related identifiers. For example, while bitting data may be directly associated with specific key blanks, it may also be associated with groups of keys, such as keys made by a specific key manufacturer or certain types of keys. Accordingly, large groups of potential key blanks may be ruled out if a bitting parameter of the master key does not match a bitting parameter shared by the group of keys.

[0034] The bitting positions can be analyzed in any number of methods. One embodiment includes first determining the pattern of the unknown subject key. Each stored pattern may then be tested against the subject key. The test may involve checking each of the known spacing positions for the stored pattern and seeing if there is a bitting at that position. To accomplish this, the logic may analyze or measure the slope or angle with respect to the length of the blade **18** of the master key pattern near the sample position and determining if there is a "flat" in that position. A flat could be defined as a small segment of the pattern (0.020" wide for example) with a slope or angle that is close to 0 degrees, (less than 17 degrees for example) that is either centered, just left or right of, the target spacing position. If a flat is identified, then the depth of the flat can also be identified from the subject key pattern relative to the reference axis.

[0035] To account for reasonable variances in the master key, the key ID system may set tolerance ranges for each bitting parameter measurement. In order for a key blank to match a master key, the comparison values must fall within the predetermined tolerance range. For example, as illustrated in the test results window of FIGS. **3-6**, the tolerance range for bitting depth may be set to plus or minus six thousandths of an inch. In order for the master key to match a key blank, each depth measurement comparison must fall within this range. As shown in FIGS. **3** and **4**, the comparison values are all between −1 and +1, indicating a match between the master key and the tested key blank or blanks. FIGS. **5** and **6**, however, illustrate comparison values of greater than 6, indicating that the master key does not match the tested key blank or blanks. The pass/fail limits (tolerance range) could be based on a set range, a set percentage of the depth offsets of the target key, or some other parameter. The limits may be set the same for all keys or may be individualized on a key-by-key basis.

[0036] To account for positional variation inherent to the subject keys and/or the inspection system, the pattern matching algorithms may be repeated while shifting the data by small increments (0.020" for example) in either or both directions. For example, if a key blank was slightly miscut and the spacing was shifted from the nominal position, the search may fail at the nominal position but may identify the pattern shifted slightly over from the nominal position.

[0037] The spacing and depth evaluations may be measured using a scoring system of 0 to 100%, where 0 is considered to be an impossible match and 100 is a perfect match. The total bitting score is then the product of the combined spacing and depth scores.

[0038] The logic may compare the bittings of a master key **10** to key data related to a key blank in the database and evaluate a series of preset spacing point for the given key

blank. For example, the geometry of the master key **10** may be analyzed at each spacing point. A score may be given to each spacing point based on the flatness of the bitting **12** at the spacing point and a measurement of the variation or slope of the bitting **12** relative to the database depths. The relationships between angles can be varied to achieve optimal results. The flatter the area near the spacing point, the higher the score. For example, zero degrees (or flat) might represent a score of 100 and 45 degrees might represent 0. Similarly, the logic may analyze the depth of the blade at each spacing point give a score to the spacing point based on the variation from one of the valid depths for the given key blank stored in the database. For example, no variation might represent a score of 100 and 2× the differences between depths might represent a score of 0.

[0039] The logic may compute this evaluation for each of the spacing points and then compute a total by averaging all the points. This entire process may be repeated with a slight shift towards the head **16** of the key **10** and again with a shift towards the tip **14** of the key **10**. This will compensate for a key **10** that has a slight spacing shift. The best of the three totals are used in the final results for the bitting evaluation.

[0040] The logic may determine the centers of each of the flats on the bittings **12** of the master key **10**. Because the center of a flat that is on the peak of a bitting may be skewed due to the depth of the bitting on the left and right, the logic may ignore peaks. The logic may also ignore ridges because the center of flats that are on ridges may be skewed due to the depth and height of the bittings **12** on either side. However, flats that are located in "valleys," or between bittings of lesser depth, are often properly centered regardless of what is on either side. For each identified valley, the logic may compare the nearest database spacing position and a score is given. A total spacing score is then computed based on the average score for each of the valleys.

[0041] It will be appreciated that the database is not limited to bittings data. In addition to bittings data, the database may store information related to other identifying parameters of the key. The key ID system may utilize other key parameters, in combination with bittings information, to narrow the field of possible key blanks.

[0042] The key ID system as described may be used in conjunction with other known key identification systems. For example, the key ID system may be used in conjunction with user interface identification systems, such as the object identification system disclosed in U.S. Publication No. 2004/0095380 and the key duplication system disclosed in U.S. Publication No. 2007/0224008, each of which are hereby incorporated by reference in their entirety.

[0043] The invention has been described above and, obviously, modifications and alternations will occur to others upon a reading and understanding of this specification. The claims as follows are intended to include all modifications and alterations insofar as they come within the scope of the claims or the equivalent thereof.

Having thus described the invention, we claim:

1. A key identification system comprising:

an imaging system configured to capture physical characteristics of a geometry of a master key; and

a logic to analyze information representative of said physical characteristics to determine characteristics of parameters of said master key and further to compare said characteristics of said parameters with stored key related information to determine the likelihood of a match between said master key and said stored key related information;

wherein said information representative of said physical characteristics includes at least one of the depth of a geometric feature and a location of a geometric feature along a blade of said master key.

2. The key identification system of claim **1**, wherein said stored key related information includes a numeric code that embodies information that represents a key cut.

3. The key identification system of claim **1**, wherein said imaging system is configured to capture an image of the side of said master key.

4. The key identification system of claim **3**, wherein said imaging system includes a camera.

5. The key identification system of claim **4**, wherein said camera is positioned perpendicular to the blade of said master key.

6. The key identification system of claim **1** further comprising a key holder to hold said master key.

7. The key identification system of claim **1**, wherein said stored key related information include bitting characteristics of a known lock.

8. The key identification system of claim **7**, wherein said characteristics of said parameters include a set of depths at given blade spacing points associated with said known lock.

9. The key identification system of claim **8**, wherein said logic computes a score for said known lock based on the comparison between the depths of said master key at each spacing point and said set of depths for said known lock.

10. The key identification system of claim **7**, wherein said characteristics of parameters include a set of bitting flat widths at given blade spacing points associated with said known lock.

11. The key identification system of claim **10** wherein said logic compares the bitting flat widths of the master key bitting at each spacing point to said set of bitting flat widths for said known lock.

12. A key identification system comprising:

an imaging system configured to capture physical characteristics of a geometry of a master key; and

a logic to analyze information representative of said physical characteristics to determine characteristics of parameters of said master key and further to compare said characteristics of said parameters with stored key related information to determine the likelihood of a match between said master key and said stored key related information;

wherein said information representative of said characteristics of said parameters includes at least one of the depth of said geometric feature and a location of said geometric feature along a blade of said master key;

wherein said logic computes a score based on a comparison between the at least one depth of said geometric feature at a spacing point and a set of depths for said stored key related information.

13. The key identification system of claim **12**, wherein said parameters include a set of bitting flat widths at given blade spacing points associated with said stored key related information.

14. The key identification system of claim **13** wherein said logic compares the bitting flat widths of the master key bitting at each spacing point to said set of bitting flat widths for said stored key related information.

15. The key identification system of claim **12**, wherein said logic analyzes one of a bitting depth, and a bitting fiat width of said master key at a blade spacing point shifted from said blade spacing point.

16. The key identification system of claim **12**, wherein said logic is configured to overlay geometric features for a plurality of known lock over said physical characteristics of said geometry of said master key.

17. The key identification system of claim **12**, wherein said logic includes a tolerance range for each characteristic of said parameter of said master key to determine whether a master key passes or fails to match a known lock.

18. The key identification system of claim **12**, wherein said logic is configured to shift the position of said characteristic of said parameter of said master key to compare with said stored key related information.

19. The key identification system of claim **18**, wherein said shift includes at least one of a move laterally towards the tip, a move longitudinally towards the head, or a rotation.

* * * * *