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*Patent Application for***MULTI-FUNCTION MEASURING INSTRUMENT****CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] The present disclosure is based on and claims benefit from co-pending U.S. Provisional Application Serial No. 62/268,756 filed December 17, 2015 entitled “Multi-Function Measuring Instrument” the entire contents of which are herein incorporated by reference.

BACKGROUNDField

[0002] The present disclosure relates generally to multi-function instruments for measuring characteristics associated with electrical wires and electrical connections. More particularly, the present disclosure relates to a multi-function instrument that can measure wire size in different metal compositions, and that can measure the resulting compression force of a crimp associated with wire connectors.

Description of the Related Art

[0003] Single function gauges used to measure for example the outer diameter of electrical conductors have been used to determine the size of a lug or connector to be used to terminate the conductor. Such single function gauges are limited to measuring a single characteristic of copper conductors, namely the outer diameter of copper conductors. However, conductors that are copper or aluminum are often used for high voltage, high current environments. Further, the size of the die needed to crimp the lug or connector to the conductor varies depending upon the size of the conductor. Having a multi-function measuring instrument that can measure multiple characteristics associated with electrical connections is needed.

SUMMARY

[0004] The present disclosure provides a measuring instrument. In one exemplary embodiment, the measuring instrument includes a main body having a first plate with a first set of measuring identifiers, a second plate with a second set of measuring identifiers, a channel between the first plate and the second plate, and a measuring arm. The measuring instrument also includes a slide arm having a measuring arm and a slide rail. The slide rail is positioned within the channel and movable relative to the main body. The slide rail also has a plurality of measuring markers that can align with at least one of the measuring identifiers.

[0005] In another exemplary embodiment, the multi-function measuring instrument includes a main body and a slide arm. The main body includes a pair of spacers, a first plate with a first set of measuring identifiers secured to a first side of each spacer, a second plate with a second set of measuring identifiers secured to a first side of each spacer and a first measuring arm extending from one of the spacers. The pair of spacers and a portion of the first plate and the second plate form a channel. The slide arm includes a second measuring arm and a slide rail. The slide rail is positioned within the channel and movable relative to the main body such that the second measuring arm can move away from or toward the first measuring arm. The slide rail includes a plurality of measuring markers such that when the slide rail is moved within the channel the measuring markers can align with at least one of the measuring identifiers, and a stop that engages at least one of the first plate or the second plate to prevent the slide arm from exiting the channel when the second measuring arm is moved away from the first measuring arm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The figures depict embodiments or configurations for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments or configuration of the structures illustrated herein may be employed without departing from the principles described herein, wherein:

[0007] Fig. 1 is a side elevation view of a first side of an exemplary embodiment of a measuring instrument according to the present disclosure;

[0008] Fig. 2 is a side elevation view of a second side of the measuring instrument of Fig. 1;

[0009] Fig. 3 is an end elevation view of the measuring instrument of Fig. 1;

[0010] Fig. 4 is a perspective view of the measuring instrument of Fig. 1;

[0011] Fig. 5 is a side perspective view of a crimped wire within a wire connector;

[0012] Fig. 6 is a side elevation view of the first side of an exemplary embodiment of a measuring instrument for measuring dimensions of copper wire;

[0013] Fig. 7 is a side elevation view of a main body of the measuring instrument of Fig. 6;

[0014] Fig. 8 is a side elevation view of a sliding arm of the measuring instrument of Fig. 6.

[0015] Fig. 9 is a side elevation view of the second side of an exemplary embodiment of a measuring instrument for measuring dimensions of aluminum wire;

[0016] Fig. 10 is a side elevation view of a main body of the measuring instrument of Fig. 9;

[0017] Fig. 11 is a side elevation view of a sliding arm of the measuring instrument of Fig. 9.

[0018] Fig. 12 is a side elevation view of the first side of the measuring instrument of Fig. 6 with a stranded copper wire positioned between the main body and slide arm for measurement;

[0019] Fig. 13 is a top plan view of a carrying sleeve for storing the measuring instrument of the present disclosure; and

[0020] Fig. 14 is a top perspective view of the sleeve of Fig. 13 with the measuring instrument of Fig. 1 inserted into the carrying sleeve.

DETAILED DESCRIPTION

[0021] The present disclosure provides a multi-function measuring instrument that can measure multiple characteristics associated with electrical conductors or wires and resulting crimps of electrical wires within wire connectors. In one exemplary embodiment, the multi-function measuring instrument is a caliper type instrument that can measure the size of electrical wires in different metal compositions, and that can measure resulting compression force of crimps associated with wire connectors. Wire connectors as used herein includes taps, terminations, splices, lugs, couplers, connectors and any other end point where a wire is secured to connection type device by a crimp. The crimps can be made by crimp tools, e.g., power crimp tools, that have dies, or the crimps can be made by die-less crimp tools, such as power crimp tools with a nest and indenter. There are numerous types of dies that can be used in crimp tools with dies. For example, the dies can be U-type, W-type, P-type, S-type and/or X-type dies. The specification and drawings are to be regarded in an illustrative sense rather than a restrictive sense. Various modifications may be made thereto without departing from the spirit and scope of the present disclosure.

[0022] Referring to Figs. 1-4, the multi-function measuring instrument 10 includes a main body 12 and a slide arm 14. The main body 12 has a first face plate 20 (seen in Fig. 1), a second face plate 30 (seen in Fig. 2), a pair of spacers 40 (seen in Fig. 4) that are spaced apart and secured between the first face plate and the second face plate and a measuring arm 16 extending from an upper end of one spacer 40. The first plate 20 and the second plate 30 are secured to the spacers 40 using for example spot welds, adhesives or mechanical fasteners such as set screws. The spacers 40 and portions of the first face plate 20 and second face plate 30 form a channel within which the slide arm 14 can fit within and slide relative to the main body 12,

[0023] The first face plate 20 has a plurality of identifiers 22 that correspond to different electrical wire characteristics. For example, the identifiers 22 can be for electrical wire sizes, for example, for stranded wire, flex wire, and/or solid wire sizes. As another example, the identifiers 22 can correspond to Diesel Locomotive (DLO) cable. Table 1 below and Figs. 6-8 provide an exemplary list of wire sizes, wire types, and the corresponding metal composition,

e.g., copper, of the wire that can be measured by the multi-function measuring instrument 10. While the wire types identified in Table 1 are for solid, stranded and DLO types, one skilled in the art would readily appreciate that the wire types could be of other constructions. Further, while the wire sizes identified in Table 1 are American Wire Gauge sizes, e.g. MCM or AWG, one skilled in the art would readily appreciate that the wire sizes could be of other sizes, such as metric based wire sizes including mm² wire sizes.

Metal Composition	Wire Type	Wire Size
Copper	Stranded	2500 MCM
Copper	Stranded	2000 MCM
Copper	Stranded	1900 MCM
Copper	Stranded	1800 MCM
Copper	Stranded	1700 MCM
Copper	Stranded	1600 MCM
Copper	Stranded	1500 MCM
Copper	Stranded	1400 MCM
Copper	Stranded	1300 MCM
Copper	Stranded	1200 MCM
Copper	Stranded	1100 MCM
Copper	Stranded	1000 MCM
Copper	Stranded	900 MCM
Copper	Stranded	800 MCM
Copper	Stranded	750 MCM
Copper	Stranded	700 MCM
Copper	Stranded	650 MCM
Copper	Stranded	600 MCM
Copper	Stranded	550 MCM
Copper	Stranded	500 MCM
Copper	Stranded	450 MCM
Copper	Stranded	400 MCM
Copper	Stranded	350 MCM
Copper	Stranded	300 MCM
Copper	Stranded	250 MCM
Copper	Stranded	4/0 AWG
Copper	Stranded	3/0 AWG
Copper	Stranded	2/0 AWG
Copper	Stranded	1/0 AWG
Copper	Stranded	1 AWG
Copper	Stranded	2 AWG
Copper	Stranded	3 AWG

Copper	Stranded	4 AWG
Copper	Stranded	6 AWG
Copper	Stranded	8 AWG
Copper	Stranded	10 AWG
Copper	Stranded	14 AWG
Copper	Stranded	16 AWG
Copper	Solid	4/0 AWG
Copper	Solid	3/0 AWG
Copper	Solid	2/0 AWG
Copper	Solid	1/0 AWG
Copper	Solid	1 AWG
Copper	Solid	2 AWG
Copper	Solid	4 AWG
Copper	Solid	6 AWG
Copper	Solid	8 AWG
Copper	Solid	10 AWG
Copper	DLO	1111 AWG
Copper	DLO	929.2 AWG
Copper	DLO	777.7 AWG
Copper	DLO	646.4 AWG
Copper	DLO	535.3 AWG
Copper	DLO	444.4 AWG
Copper	DLO	373.7 AWG
Copper	DLO	313.1 AWG
Copper	DLO	262.6 AWG
Copper	DLO	4/0 AWG
Copper	DLO	3/0 AWG
Copper	DLO	2/0 AWG
Copper	DLO	1/0 AWG
Copper	DLO	1 AWG
Copper	DLO	2 AWG
Copper	DLO	4 AWG
Copper	DLO	6 AWG
Copper	DLO	8 AWG
Copper	DLO	10 AWG
Copper	DLO	14 AWG

TABLE 1

[0024] The first face plate 20 also has a plurality of identifiers 24 that correspond to compression force range of crimps (shown as block regions) exerted by crimp dies, e.g., “U” type crimp dies, “W” type crimp dies or other crimp dies, used in a power crimping tool, and used to crimp wires to wire connectors. For example, the identifiers 24 can be the compression

force range dimensions exerted by “U” type crimp dies used with known power crimping tools, and are measured by a “T” dimension, which is a dimension measured to ensure the correct die type, e.g., “U” type die or “W” type die, was used to crimp a wire connector to a wire. The “T” dimension, shown in Fig. 5, represents the outer periphery of a wire connector after a wire has been crimped within the wire connector by a die and crimping tool. After being crimped the outer periphery of the wire connector will be compressed and altered by the crimp. As a result, the “T” dimension range on the multi-function measuring instrument 10 identifies whether the proper die and crimp force was used to crimp a wire to a wire connector. Table 2 below and Figs. 6-8 provide an exemplary list of compression force ranges exerted by “U” type dies, and respective “T” dimensions on certain metal, e.g., copper, compositions that can be measured by the multi-function measuring instrument 10. However, while the exemplary embodiments described herein are associated with the use of crimp tools with dies, the multi-function measuring instrument 10 can be configured for use with die-less crimp tools or for use with die type crimp tools in combination with die-less crimp tools.

Metal Composition	Die Type	Range
Copper	U44XRT	12-15 tons
Copper	U36RT	12-15 tons
Copper	U32RT	12-15 tons
Copper	U30RT	12-15 tons
Copper	U28RT	12-15 tons
Copper	U26RT	12-15 tons
Copper	U1CRT	12-15 tons
Copper	U3CRT	12-15 tons
Copper	U5CRT	12-15 tons
Copper	U35RT	12-15 tons
Copper	U38XRT	12-15 tons
Copper	U34RT	12-15 tons
Copper	U31RT	12-15 tons
Copper	U29RT	12-15 tons
Copper	U27RT	12-15 tons
Copper	U26RT	12-15 tons
Copper	U2CRT	12-15 tons
Copper	U4CRT	12-15 tons
Copper	U8CRT	12-15 tons

TABLE 2

[0025] The second face plate 30 also has a plurality of identifiers 32 that correspond to different electrical wire characteristics. For example, the identifiers 32 can be for electrical wire sizes for stranded wire, flex wire, and/or solid wire sizes. As another example, the identifiers 32 can correspond to 1350 compact cable. Table 3 below and Figs. 9-11 provide an exemplary list of wire sizes, wire types, and the corresponding metal composition, e.g., aluminum, of the wire that can be measured by the multi-function measuring instrument 10. As noted above, while the wire types identified in Table 3 are for solid, stranded and DLO types, one skilled in the art would readily appreciate that the wire types could be of other constructions. Further, while the wire sizes identified in Table 3 are American Wire Gauge sizes, e.g. MCM or AWG, one skilled in the art would readily appreciate that the wire sizes could be of other sizes, such as metric based wire sizes including mm² wire sizes.

Metal Composition	Wire Type	Wire Size
Aluminum	Stranded	3500 MCM
Aluminum	Stranded	3000 MCM
Aluminum	Stranded	2500 MCM
Aluminum	Stranded	2000 MCM
Aluminum	Stranded	1900 MCM
Aluminum	Stranded	1800 MCM
Aluminum	Stranded	1700 MCM
Aluminum	Stranded	1600 MCM
Aluminum	Stranded	1500 MCM
Aluminum	Stranded	1400 MCM
Aluminum	Stranded	1300 MCM
Aluminum	Stranded	1200 MCM
Aluminum	Stranded	1100 MCM
Aluminum	Stranded	1000 MCM
Aluminum	Stranded	900 MCM
Aluminum	Stranded	800 MCM
Aluminum	Stranded	750 MCM
Aluminum	Stranded	700 MCM
Aluminum	Stranded	650 MCM
Aluminum	Stranded	600 MCM
Aluminum	Stranded	550 MCM
Aluminum	Stranded	500 MCM
Aluminum	Stranded	450 MCM
Aluminum	Stranded	400 MCM

Aluminum	Stranded	350 MCM
Aluminum	Stranded	300 MCM
Aluminum	Stranded	250 MCM
Aluminum	Stranded	4/0 AWG
Aluminum	Stranded	3/0 AWG
Aluminum	Stranded	2/0 AWG
Aluminum	Stranded	1/0 AWG
Aluminum	Stranded	1 AWG
Aluminum	Stranded	2 AWG
Aluminum	Stranded	3 AWG
Aluminum	Stranded	4 AWG
Aluminum	Stranded	6 AWG
Aluminum	Stranded	8 AWG
Aluminum	Stranded	10 AWG
Aluminum	Stranded	14 AWG
Aluminum	Stranded	18 AWG
Aluminum	Compact 1350	1100 MCM
Aluminum	Compact 1350	1000 MCM
Aluminum	Compact 1350	900 MCM
Aluminum	Compact 1350	800 MCM
Aluminum	Compact 1350	750 MCM
Aluminum	Compact 1350	700 MCM
Aluminum	Compact 1350	650 MCM
Aluminum	Compact 1350	600 MCM
Aluminum	Compact 1350	550 MCM
Aluminum	Compact 1350	500 MCM
Aluminum	Compact 1350	450 MCM
Aluminum	Compact 1350	400 MCM
Aluminum	Compact 1350	350 MCM
Aluminum	Compact 1350	300 MCM
Aluminum	Compact 1350	250 MCM
Aluminum	Compact 1350	4/0 AWG
Aluminum	Compact 1350	3/0 AWG
Aluminum	Compact 1350	2/0 AWG
Aluminum	Compact 1350	1/0 AWG
Aluminum	Compact 1350	1 AWG
Aluminum	Compact 1350	2 AWG
Aluminum	Compact 1350	3 AWG
Aluminum	Compact 1350	4 AWG
Aluminum	Compact 1350	6 AWG
Aluminum	Compact 1350	8 AWG

TABLE 3

[0026] The second face plate 30 also has a plurality of identifiers 34 that correspond to compression force range of crimps (shown as block regions) exerted by crimp dies, e.g., “U” type crimp dies, “W” type crimp dies or other crimp dies, used in a power crimping tool, and used to crimp a wire to wire connector. For example, the identifiers 34 can be the compression force range dimensions exerted by known “U” type crimp dies used with known crimping tools, and are measured by a “T” dimension, which is a dimension measured to ensure the correct die type, e.g., “U” type die, was used to crimp a wire connector to a wire. Table 4 below and Figs. 9-11 provide an exemplary list of compression force ranges exerted by “U” type dies, and respective “T” dimensions of certain metal compositions, e.g., aluminum, that can be measured by the multi-function measuring instrument 10. However, as noted above while the exemplary embodiments described herein are associated with the use of crimp tools with dies, the multi-function measuring instrument 10 can be configured for use with die-less crimp tools or for use with die type crimp tools in combination with die-less crimp tools.

Metal Composition	Die Type	Range
Aluminum	U36ART	12-15 tons
Aluminum	U32ART	12-15 tons
Aluminum	U30ART	12-15 tons
Aluminum	U28ART	12-15 tons
Aluminum	U26ART	12-15 tons
Aluminum	U1CART	12-15 tons
Aluminum	U4CABT	12-15 tons
Aluminum	U8CABT	12-15 tons
Aluminum	U39ART2	12-15 tons
Aluminum	U34ART	12-15 tons
Aluminum	U31ART	12-15 tons
Aluminum	U29ART	12-15 tons
Aluminum	U27ART	12-15 tons
Aluminum	U25ART	12-15 tons
Aluminum	U2CABT	12-15 tons
Aluminum	U4CRT	12-15 tons
Aluminum	U8CRT	12-15 tons

TABLE 4

[0027] The slide arm 14 is configured to fit within and slide within the channel between the face plates 20 and 30 of the main body 12, as shown in Fig. 4. The slide arm 14, seen for

example in Fig. 8, includes a measuring arm 17 connected to a slide rail 18. The measuring arm 17 extends from an upper surface of the slide rail 18, and the slide rail rests within the channel between the face plates. As such, the slide arm 14 can slide relative to the main body 12. The stop 13, e.g., a detent on one side of the slide rail 18, seen in Fig. 9, prevents the slide arm 14 from sliding out of the channel when the measuring arm 17 of the slide arm 14 is moved away from the measuring arm 16 of the main body 12. The slide arm 14 also includes one or more measuring markers 15, which in this exemplary embodiment comprises measuring markers 15a-15e. The measuring markers 15 are intended to align with respective identifiers 22, 24, 32 and/or 34 when making a measurement. For example, as seen in Fig. 12, a stranded copper wire 100 is positioned between the measuring arm 16 and measuring arm 17. Using the copper (CU) side of the slide arm 14, measuring marker 15a reflects that the measured wire size (identifier 22) is a 4/0 AWG stranded copper wire. If the wire was a solid wire type, then the measuring marker 15b would be used to measure the wire size. If the wire type were a DLO wire type, then the measuring marker 15c would be used to measure the wire size. If a lug or connector were crimped to a copper wire and the crimped lug or connector were placed between the measuring arms 16 and 17, the measuring markers 15d and 15e would be used to measure the compression force range and “T” dimension. If the wire being measured was aluminium, then the aluminium (AL) side of the slide arm 14 would be used to make the above measurements.

[0028] Referring to Figs. 13 and 14, a carrying case or sleeve 60 may be provided to house the measuring device 10 when not in use. The sleeve 60 has a bottom portion 62 and a top portion 64. The bottom portion 62 receives the main body 12 and the slide rail 18 of the slide arm 14. The top portion 64 receives the measuring arm 16 of the main body 12 and the measuring arm 17 of the slide arm 14. The sleeve 60 may include an area 66 for a corporate logo, and/or may include an area for other information for the user, such as a conversion table.

[0029] However, it will be understood that various modifications can be made to the configurations of the present disclosure herein without departing from the spirit and scope thereof. Therefore, the above description should not be construed as limiting the disclosure, but merely as embodiments or configurations thereof. Those skilled in the art will envision other

modifications within the scope and spirit of the invention as defined by the claims appended hereto.

CLAIMS**What is claimed is:**

1. A multi-function measuring instrument comprising:
a main body having a pair of spacers, a first plate with a first set of measuring identifiers secured to a first side of each spacer, a second plate with a second set of measuring identifiers secured to a first side of each spacer, wherein the pair of spacers and a portion of the first plate and the second plate form a channel, and a first measuring arm extending from one of the spacers; and
a slide arm having a second measuring arm and a slide rail, wherein the slide rail is positioned within the channel and movable relative to the main body such that the second measuring arm can move away from or toward the first measuring arm, the slide rail also having a plurality of measuring markers such that when the slide rail is moved within the channel the measuring markers can align with at least one of the measuring identifiers.
2. The multi-function measuring instrument according to claim 1, wherein the first set of identifiers comprise at least one electrical wire characteristic for copper wire and at least one compression force range for copper wire associated with a predefined die type.
3. The multi-function measuring instrument according to claim 2, wherein the predetermined die type comprises a U type die.
4. The multi-function measuring instrument according to claim 2, wherein the predetermined die type comprises a W type die.
5. The multi-function measuring instrument according to claim 2, wherein the at least one electrical wire characteristic for copper wire comprises a wire size.
6. The multi-function measuring instrument according to claim 2, wherein the at least one electrical wire characteristic for copper wire comprises a wire type.

7. The multi-function measuring instrument according to claim 6, wherein the wire type comprises solid, stranded and DLO wire types.
8. The multi-function measuring instrument according to claim 1, wherein the first set of identifiers comprise at least one electrical wire characteristic for copper wire and at least one compression force range for copper wire associated with a die-less type crimp.
9. The multi-function measuring instrument according to claim 1, wherein the second set of identifiers comprise at least one electrical wire characteristic for aluminum wire and at least one compression force range for aluminum wire associated with a predefined die type.
10. The multi-function measuring instrument according to claim 9, wherein the predetermined die type comprises a U type die.
11. The multi-function measuring instrument according to claim 9, wherein the predetermined die type comprises a W type die.
12. The multi-function measuring instrument according to claim 9, wherein the at least one electrical wire characteristic for aluminum wire comprises a wire size.
13. The multi-function measuring instrument according to claim 9, wherein the at least one electrical wire characteristic for aluminum wire comprises a wire type.
14. The multi-function measuring instrument according to claim 13, wherein the wire type comprises solid, stranded and DLO wire types.
15. The multi-function measuring instrument according to claim 1, wherein the second set of identifiers comprise at least one electrical wire characteristic for aluminum wire and at least one compression force range for aluminum wire associated with a die-less type crimp.

16. The multi-function measuring instrument according to claim 1, wherein the slide rail further comprises a stop that engages at least one of the first plate and the second plate to prevent the slide arm from exiting the channel when the second measuring arm is moved away from the first measuring arm.

17. The multi-function measuring instrument according to claim 16, wherein the stop comprises a detent.

18. A multi-function measuring instrument comprising:

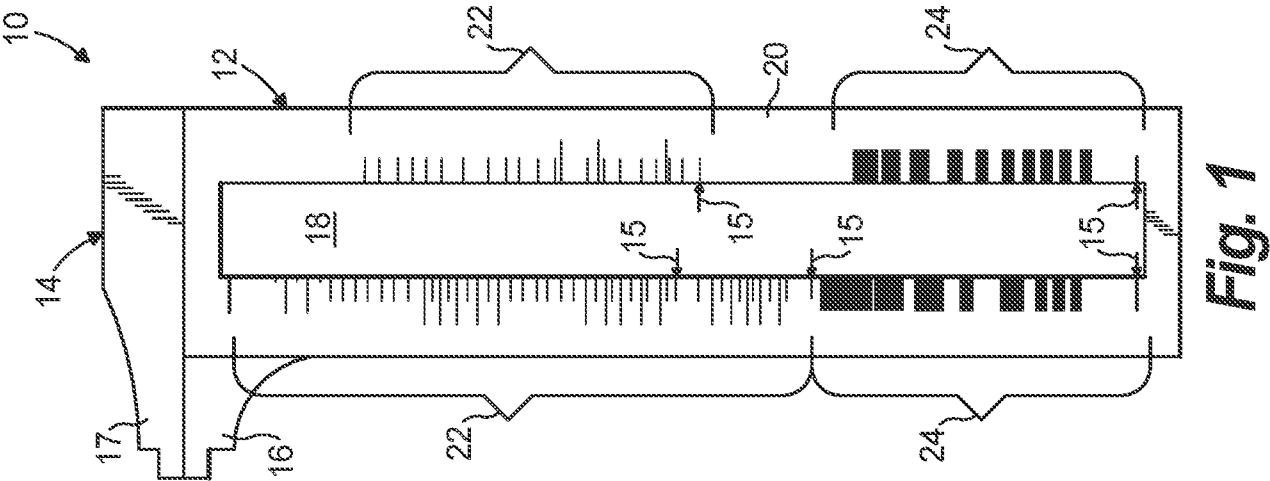
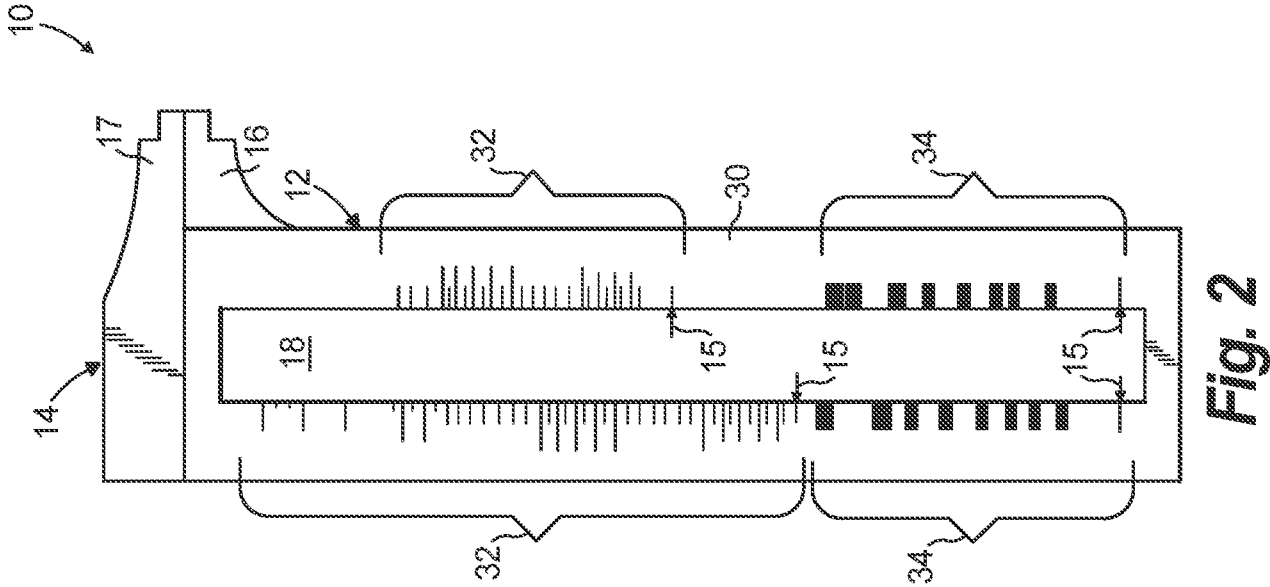
a main body having a pair of spacers, a first plate with a first set of measuring identifiers secured to a first side of each spacer, a second plate with a second set of measuring identifiers secured to a first side of each spacer, wherein the pair of spacers and a portion of the first plate and the second plate form a channel, and a first measuring arm extending from one of the spacers; and

a slide arm having a second measuring arm and a slide rail, wherein the slide rail is positioned within the channel and movable relative to the main body such that the second measuring arm can move away from or toward the first measuring arm, the slide rail comprise a plurality of measuring markers such that when the slide rail is moved within the channel the measuring markers can align with at least one of the measuring identifiers, and a stop that engages at least one of the first plate and the second plate to prevent the slide arm from exiting the channel when the second measuring arm is moved away from the first measuring arm.

19. The multi-function measuring instrument according to claim 18, wherein the first set of identifiers comprise at least one electrical wire characteristic for copper wire and at least one compression force range for copper wire associated with a predefined die type.

20. The multi-function measuring instrument according to claim 18, wherein the first set of identifiers comprise at least one electrical wire characteristic for copper wire and at least one compression force range for copper wire associated with a die-less type crimp.

21. The multi-function measuring instrument according to claim 18, wherein the second set of identifiers comprise at least one electrical wire characteristic for aluminum wire and at least one compression force range for aluminum wire associated with a predefined die type.
22. The multi-function measuring instrument according to claim 18, wherein the second set of identifiers comprise at least one electrical wire characteristic for aluminum wire and at least one compression force range for aluminum wire associated with a die-less type crimp.
23. The multi-function measuring instrument according to claim 18, wherein the stop comprises a detent.



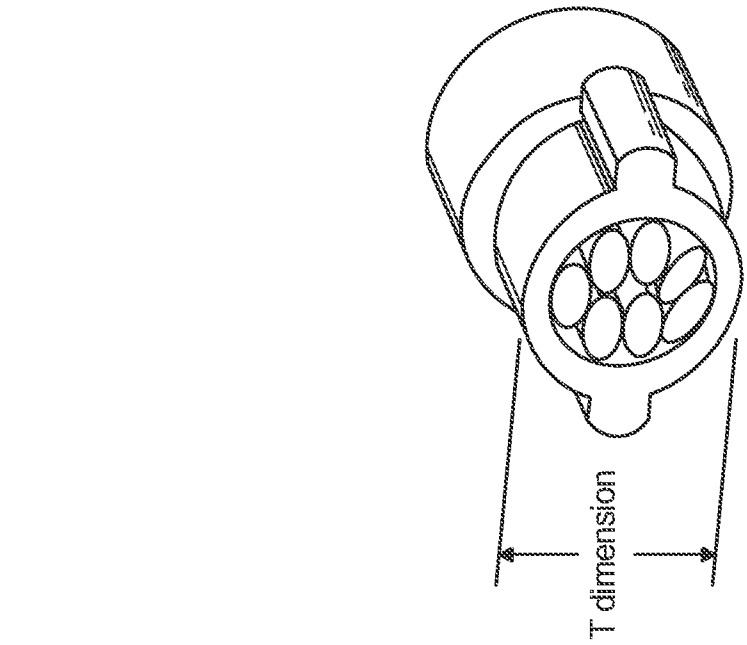


Fig. 5

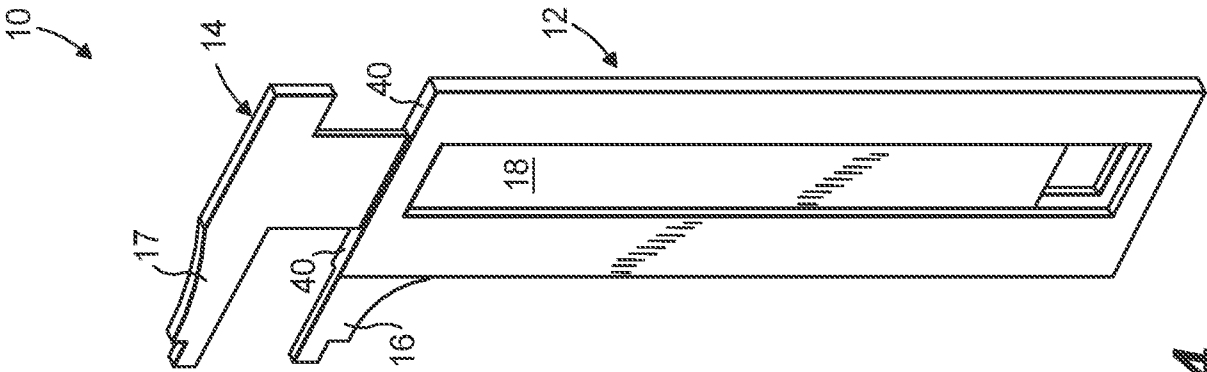


Fig. 4

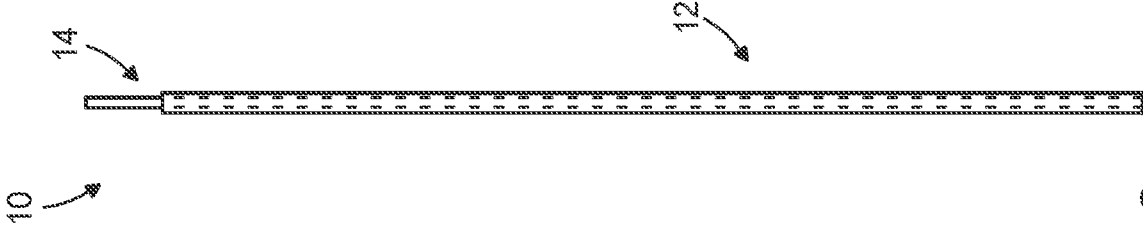


Fig. 3

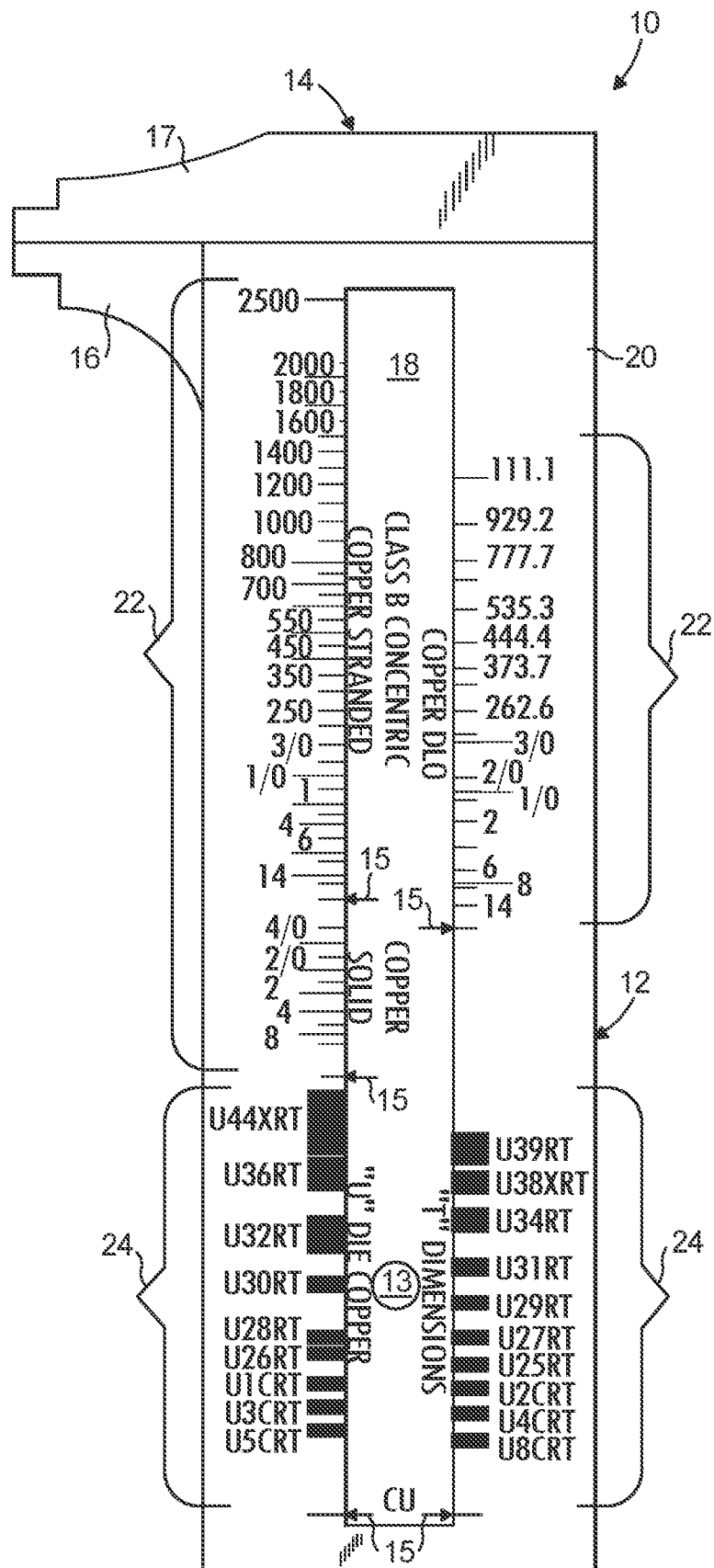
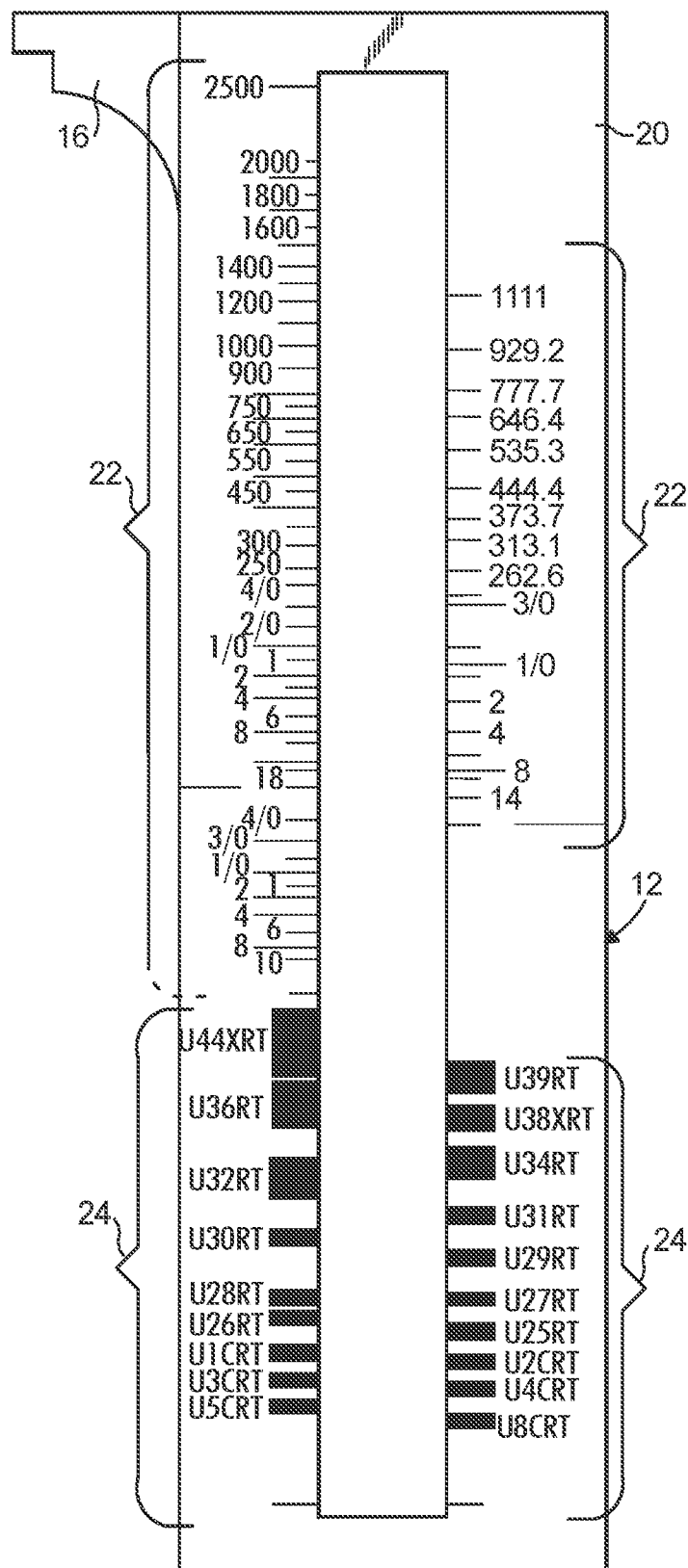


Fig. 6

**Fig. 7**

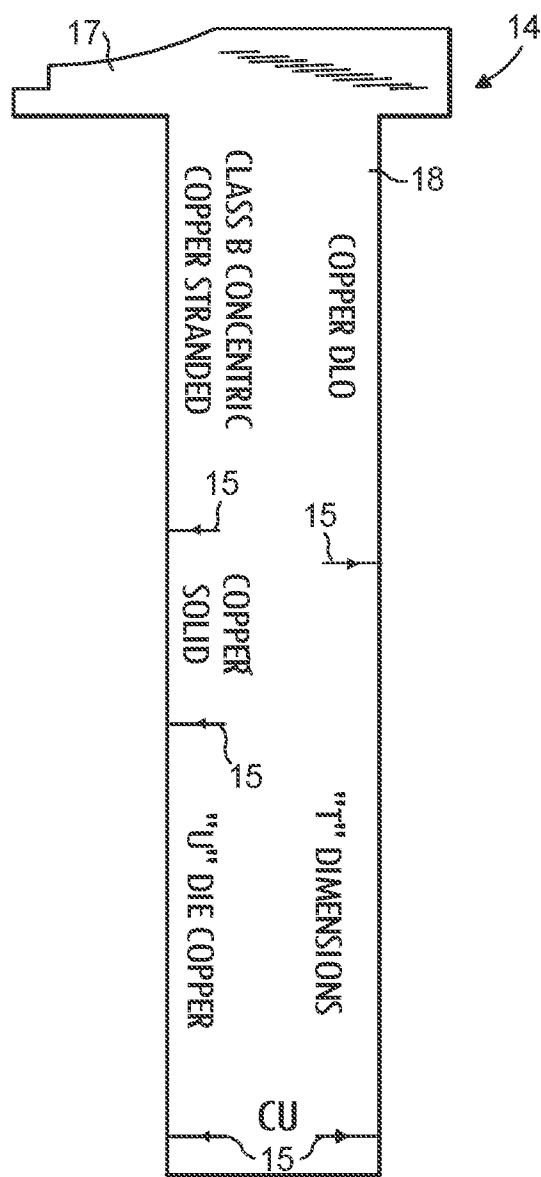


Fig. 8

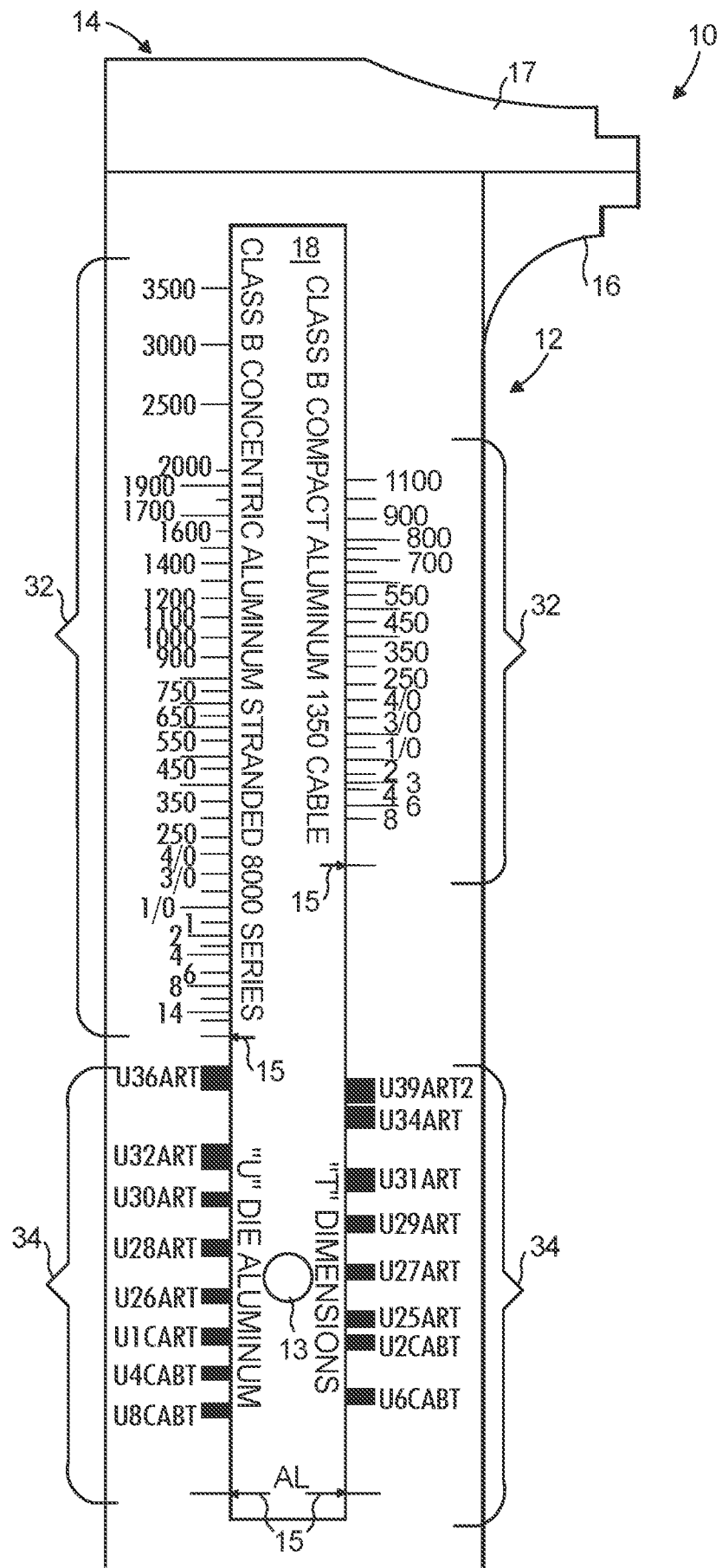


Fig. 9

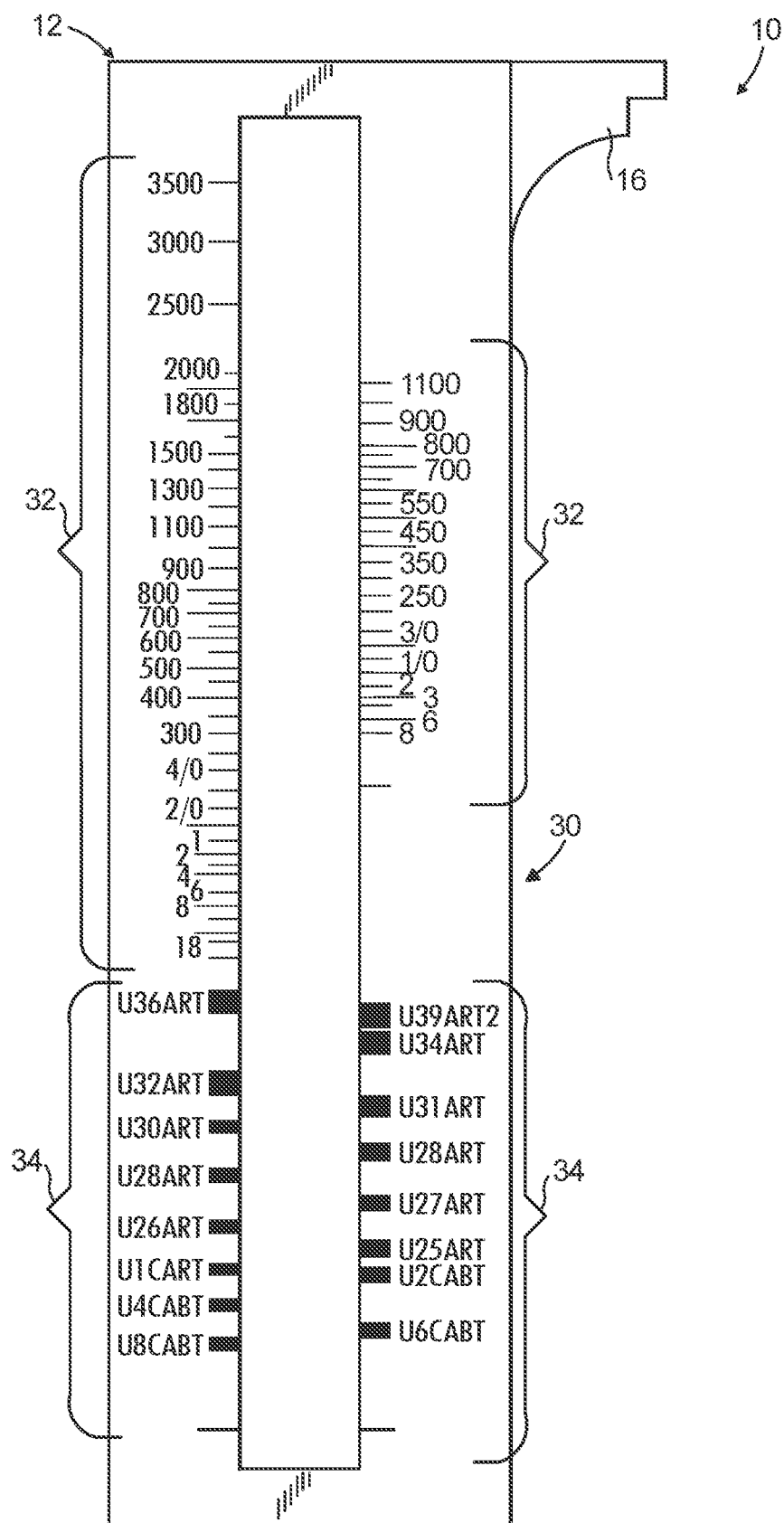


Fig. 10

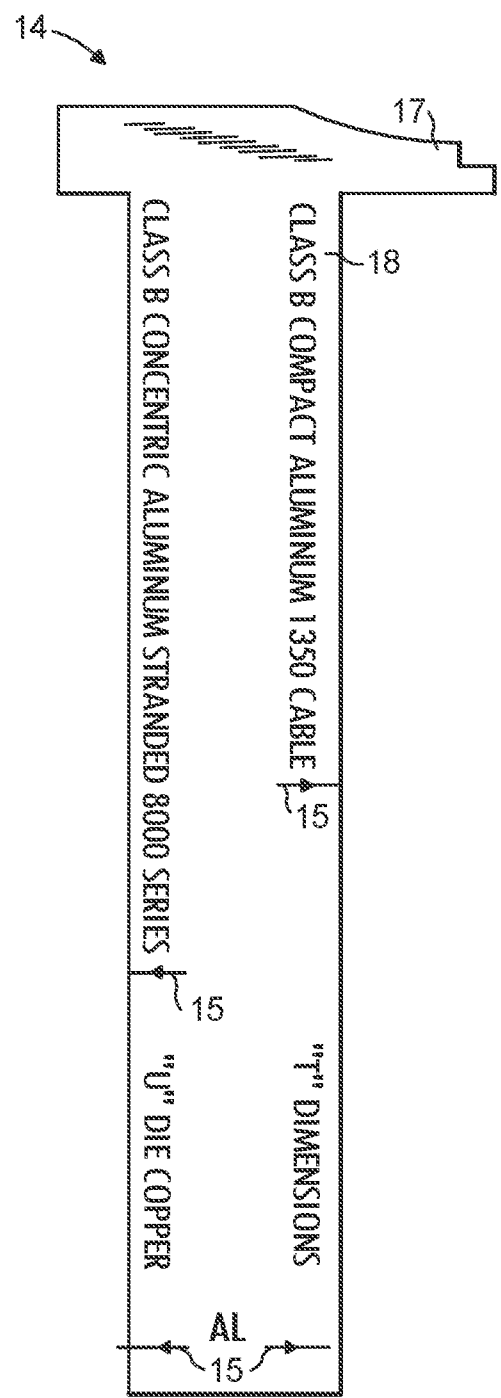


Fig. 11

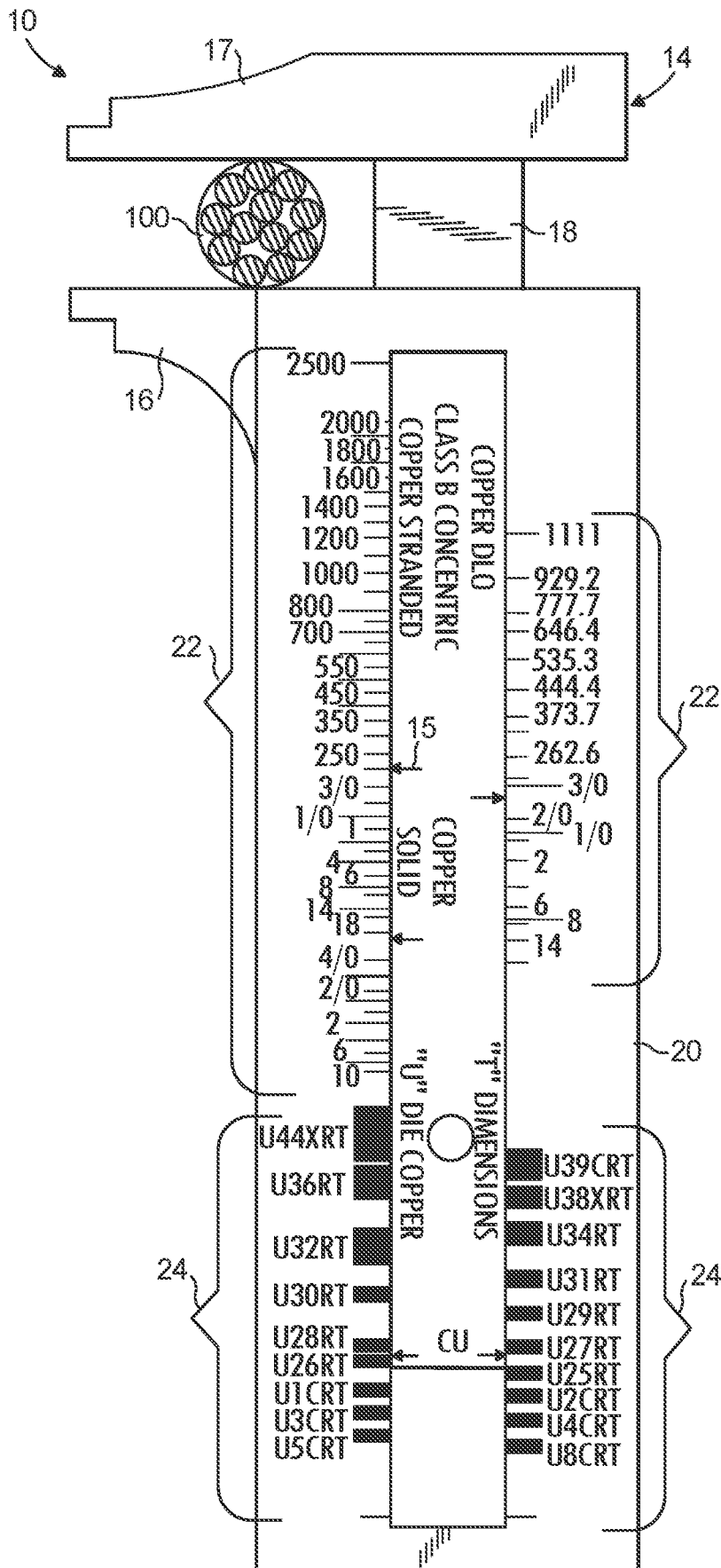
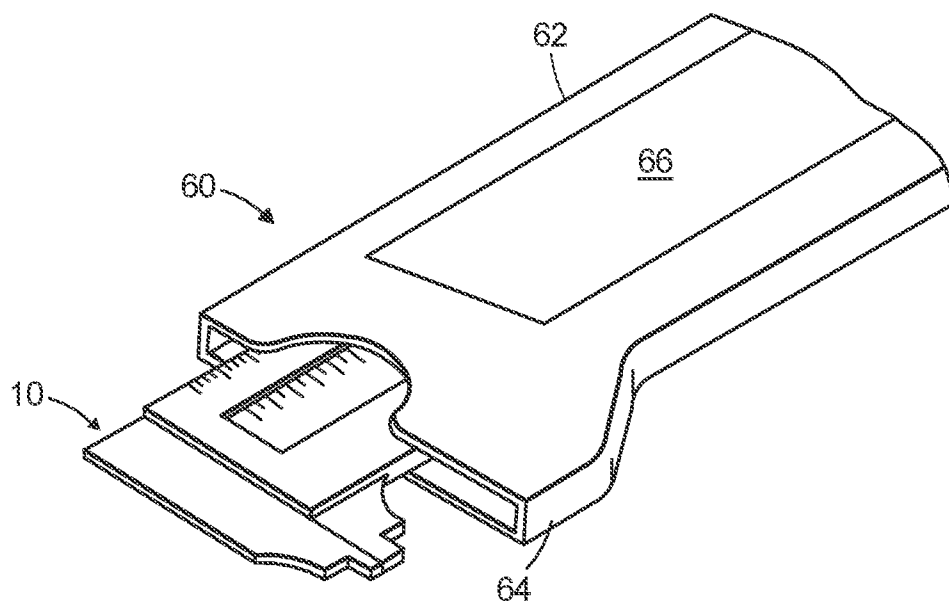
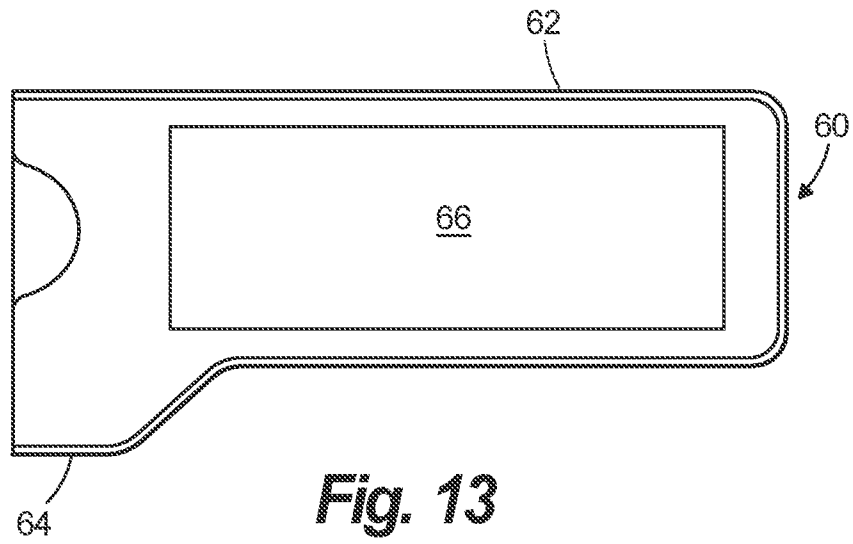


Fig. 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/67308

A. CLASSIFICATION OF SUBJECT MATTER

IPC - G01B 3/08, 3/20, 5/30; G01D 7/04; H01R 43/048 (2017.01)
 CPC - G01B 3/004, 3/08, 3/20, 5/30; G01D 7/04; H01R 43/0486

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- A	US 2,874,478 A (FAULCONER, T) February 24, 1959; figures 1, 3-5, column 1, lines 48-56, line 63 to column 2, line 43	1, 16-18, & 23 --- 2-15 & 19-22
A	US 2,668,464 A (PAULES, L) February 9, 1954; figure 2, column 3, lines 49-59	2-15 & 19-22
A	US 6,073,472 A (HOLLINGSWORTH, E) June 13, 2000; figure 2, column 3, lines 37-63	2-15 & 19-22
A	US 4,655,064 A (HOBACK, G) April 7, 1987; figures 1, 2, 7, 9, column 3, lines 8-62	2-7, 9-14, 19, & 21
A	US 5,195,042 A (FERRARO, N et al.) March 16, 1993; figure 3, column 5, lines 12-17, column 9, lines 48-60	8, 15, 20, & 22

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search

10 February 2017 (10.02.2017)

Date of mailing of the international search report

02 MAR 2017

Name and mailing address of the ISA/

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