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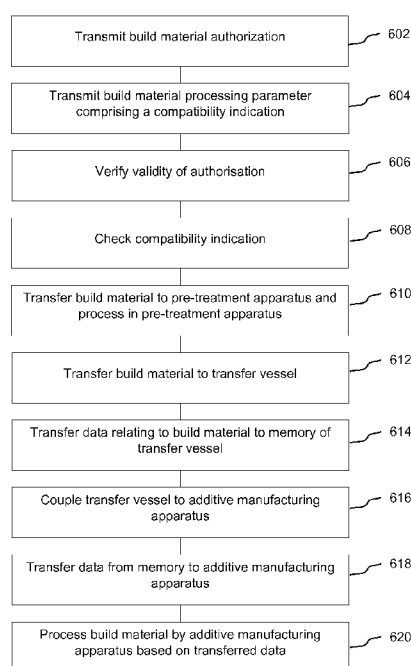


Fig. 6

(57) Abstract: In an example, processing circuitry includes a data source to provide a plurality of additive manufacturing parameters, a communications interface to communicate with an additive manufacturing build material processing apparatus and an authentication module. The authentication module is to receive an authentication request from an additive manufacturing build material processing apparatus and to provide an authentication response for communication to the additive manufacturing build material processing apparatus. The communications interface is to transmit data from the data source to the additive manufacturing build material processing apparatus.

ADDITIVE MANUFACTURING AUTHENTICATION

BACKGROUND

[0001] Additive manufacturing techniques such as three-dimensional (3D) printing relate to techniques for making 3D objects of almost any shape from a digital 3D model through additive processes, in which 3D objects are generated on a layer-by-layer basis under computer control. A large variety of additive manufacturing technologies have been developed differing in build materials, deposition techniques and processes by which the 3D object is formed from the build material. Such techniques may range from applying ultraviolet light to photopolymer resin, to melting semi-crystalline thermoplastic materials in powder form, to electron-beam melting of metal powders.

[0002] Additive manufacturing processes may begin with a digital representation of a 3D object to be manufactured. This digital representation may be virtually sliced into layers by computer software or may be provided in pre-sliced format. Each layer represents a cross-section of the object to be manufactured, and is sent to an additive manufacturing apparatus (also termed a “3D printer”) where it is built upon a previously built layer. This process is repeated until the object is completed, thereby building the object layer-by-layer. While some available technologies directly print material, others use a recoating process to form additional layers that can then be selectively solidified in order to create the new cross-section of the object.

[0003] The build material from which the object is manufactured may vary depending on the manufacturing technique and may comprise powder material, paste material, slurry material or liquid material. The build material is usually provided in a source container from where it needs to be transferred to the building area or building compartment of the additive manufacturing apparatus where the actual manufacturing takes place.

DRAWINGS

- [0004]** Figure 1 is a schematic drawing of example processing circuitry;
- [0005]** Figures 2A and 2B are schematic drawings of another example processing circuitry arranged on a mounting;
- [0006]** Figure 3 is a schematic drawing of an example build material container;
- [0007]** Figure 4 is an example method of providing processing circuitry;
- [0008]** Figure 5 is example method for use in additive manufacturing processes;
- [0009]** Figure 6 is another example method for use in in additive manufacturing processes;
- [0010]** Figure 7 is a schematic drawing of an example transfer vessel;
- [0011]** Figure 8 is a schematic drawing of an example additive manufacturing materials processing unit; and
- [0012]** Figure 9 is a schematic drawing of another example additive manufacturing materials processing unit.

DESCRIPTION

- [0013]** Three-dimensional objects can be generated using additive manufacturing techniques. The objects may be generated by solidifying portions of successive layers of build material. The build material can be powder-based and the properties of generated objects may be dependent on the type of build material and the type of solidification. In some examples, solidification of the powder material is enabled using a liquid fusing agent. In further examples, solidification may be enabled by temporary application of energy to the build material. In certain examples, fusing and/or bind agents are applied to build material, wherein a fusing agent is a material that, when a suitable amount of energy is applied to a combination of build material and fusing agent, causes the build material to fuse and solidify. In other examples, other build materials and other methods of solidification may be used. In certain examples, the build material includes paste material, slurry material or liquid material.
- [0014]** Source containers for adding build material to the additive manufacturing process may be provided. In one example the build material in the source build material container is powder that has an average volume-based cross sectional

particle diameter size of between approximately 5 and approximately 400 microns, between approximately 10 and approximately 200 microns, between approximately 15 and approximately 120 microns or between approximately 20 and approximately 80 microns. Other examples of suitable, average volume-based particle diameter ranges include approximately 5 to approximately 80, or approximately 5 to approximately 35 microns. In this disclosure a volume-based particle size is the size of a sphere that has the same volume as the powder particle. With “average” it is intended to imply that most of the volume-based particle sizes in the container are of the mentioned size or size range but that the container may also contain particles of diameters outside of the mentioned range. For example, the particle sizes may be chosen to facilitate distributing build material layers having thicknesses of between approximately 10 and approximately 500 microns, or between approximately 10 and approximately 200 microns, or between approximately 15 and approximately 150 microns. One example of an additive manufacturing system may be pre-set to distribute build material layers of approximately 90 microns using build material containers that contain powder having average volume-based particle diameters of between approximately 40 and approximately 60 microns. For example the additive manufacturing apparatus can be reset to distribute different layer thicknesses.

[0015] Examples of powder-based build materials include at least one of polymers, crystalline plastics, semi-crystalline plastics, polyethylene (PE), polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), amorphous plastics, Polyvinyl Alcohol Plastic (PVA), Polyamide, thermo(setting) plastics, resins, transparent powders, colored powders, metal powder, ceramics powder such as for example glass particles, and/or a combination of at least two of these or other materials wherein such combination may include different particles each of different materials or different materials in a single compound particle. Examples of blended build materials include alumide, which may include a blend of aluminium and polyamide, multi-color powder, and plastics/ceramics blends.

[0016] In additive manufacturing, it may be the case that build materials become heated. For example, where fusing agents are applied and caused to absorb energy, this tends to heat the build material, in particular in the regions to which fusing agents have been applied. In addition, some additive manufacturing processes may pre-heat

build materials, or may comprise exothermic chemical reactions or the like. In such processes, there is a possibility of build material overheating, for example to the point where it could damage apparatus or even ignite.

[0017] Different build materials may be associated with different processing temperatures. For example, different materials may have different melting points, or different flash points (the flash point is the temperature at which a build material may evaporate to such an extent that the vapour may ignite). In addition, different temperatures may result in different physical properties of an object, such as object strength, resilience, appearance or the like.

[0018] A particular additive manufacturing apparatus may be intended to be used with a range of such materials and therefore may comprise settings (temperature settings, layer processing times, etc.) which are matched to the build material being processed thereby. If too high a temperature is reached during object generation for a particular build material, there are risks, which may include an object failing to be manufactured as intended, damage to equipment, and/or the possibility of explosions and/or fire. In some examples, the additive manufacturing apparatus may be arranged for operation with a particular build material or range thereof, and attempting to manufacture an object using a different build material may result in similar risks.

[0019] In addition to considering careful handling of individual build materials, consideration may also be made in relation to mixtures of build material, even at a trace level. For example, a poorly considered mixture may result in failure to manufacture an object as intended, as different melting temperatures may mean that some material within the mixture melts and other does not, or some material may overheat. In other examples, the object may have unintended properties as a result of a poorly considered mixture. Moreover, different build materials may react adversely with one another, for example when heat is applied (for example, when the build material is molten or in a vapour state). Again, there may be risks of damage to apparatus, infrastructure or personnel.

[0020] In examples set out herein, a supply of build material may be associated with a memory or data source providing at least one additive manufacturing parameter, which (as is discussed in greater detail below) may be or include a build material parameter (e.g. describing an aspect or attribute of the build material), or an

authorisation parameter, which may comprise part of an 'authorisation to print' operation, for example unlocking the additive manufacturing apparatus for use. In some examples, the association may be a physical association, for example a solid state memory or other data source may be attached to or contained within a container in which the build material is transported. However, even if a set of parameters is physically or otherwise associated with a supply of build material, it may be that counterfeit or uncontrolled sources of build material are available. Thus, in some examples set out herein, the source of the data is verifiable such that a user may be confident that the build material is from a trusted source and is, or will behave, as described by the parameter(s).

[0021] Figure 1 shows an example of processing circuitry. For example, the processing circuitry 100 may comprise an integrated circuit chip, but could comprise any processing circuitry such as a general purpose computer, a hand held computer, or the like. The processing circuitry 100 comprises a data source, in this example a memory 102. The memory 102 may for example comprise non-volatile memory, such as at least one of read-only memory (ROM, or erasable programmable ROM, EPROM), flash memory, ferroelectric RAM (F-RAM), magnetic memory, optical memory or the like. In some examples, the processing circuitry 100 may be provided on a mounting which is adapted for tool-less insertion and/or removal from a build material container. This increases the flexibility of the processing circuitry as it may be added to or removed from a build material container without any tools (and thus may for example be easily removed or added by an end user). In some examples, the memory 102 may store data for a prolonged period. In other examples, the memory 102 may be for temporary storage of data, for example following generation thereof in response to a request for data.

[0022] The processing circuitry 100 further comprises a communications interface 104 to communicate with an additive manufacturing build material processing apparatus. For example, this may be an additive manufacturing apparatus (or '3D printer') which fabricates an object in a layer wise manner, or may be a build material treatment apparatus, such as a pre-treatment apparatus, for example a build material mixing and/or preparation apparatus, a post-manufacture treatment apparatus (which may for example extract unfused build material from an object fabrication chamber) or

some other apparatus for use in additive manufacturing. In some examples, the communications interface 104 may comprise a galvanic interface, i.e. an electrical connection is made over which data may be sent or received. In other examples, the communications interface 104 may operate using 'wireless' communication methods, such as radio or optical transmission methods. Data from the memory 102 may be transmitted to the additive manufacturing build material processing apparatus by the communications interface 104.

[0023] The processing circuitry 100 further comprises an authentication module 106. The authentication module 106 may for example comprise at least one processor and may be arranged to receive an authentication request from an additive manufacturing build material processing apparatus (for example, received via the interface) and to provide an authentication response for communication to the additive manufacturing build material processing apparatus. This authentication may be based on an additive manufacturing parameter stored in the memory 102, for example a cryptographic secret code or password or the like.

[0024] Thus, the processing circuitry 100 may be arranged to provide the additive manufacturing build material processing apparatus with parameters via the communications interface 104, and the authentication module 106 may be to provide the additive manufacturing build material processing apparatus with validation of that data, and/or with validation of the source of the build material. The additive manufacturing build material processing apparatus may then (in some examples, on completion of checking of the validity of the authentication response) trust the content of the data. In some examples, the processing circuitry 100 may be associated with a particular source of build material, for example being provided on or in a build material container. In such examples, once the authentication response is verified, it may be that the build material is also considered to be verified and the subsequent processing thereof can be conducted with confidence that both the data and the build material itself are from a trusted source.

[0025] For example, the authentication module 106 may be arranged to receive an authentication request comprising a message, to encrypt the message (for example using a key issued thereto at manufacture) and provide an authentication response which includes the encrypted message. The build material processing apparatus may

know the key (for example, all instances of a plurality of processing circuitries may be provided with the same key, or a one of a limited number of keys), or may be able to derive the key based on, for example, another portion of the message. By sending the encrypted message, the processing circuitry 100 proves that it has access to the key, and, as long as it can be trusted that the key has been distributed in a secure manner, this authenticates the identity of the processing circuitry 100. For example, the authentication and/or encryption may comprise a Diffie-Hellman key exchange, an RSA (Rivest-Shamir-Adleman) system, or be based on the ElGamal cryptosystem or the like.

[0026] The authentication response may comprise, or form the basis of, a release code for the additive manufacturing build material processing apparatus, the release code being to authorize at least one additive manufacturing process of the additive manufacturing build material processing apparatus. For example, the release code may comprise a 'right to print' authorization, which allows an additive manufacturing apparatus to print an object (in some cases conditional on attributes of the object, such as the volume or material property specifications being reproducible using the build material associated with the processing circuitry 100, or on an additive manufacturing apparatus being suitable to process the build material, or there being sufficient build material available) or the like.

[0027] In some examples, the authentication may be two-way, i.e., the authentication module 106 may authenticate the additive manufacturing build material processing apparatus, for example by authenticating the request. It may be, for example, that data is not transmitted to the additive manufacturing build material processing apparatus unless the request is authenticated. In some examples, it may be that an authentication response is not transmitted unless the request is authenticated, for example by use of a shared secret and/or a digital signature or the like.

[0028] In some examples, the additive manufacturing parameters may be stored in an encrypted form. In such examples, the processing circuitry 100 may comprise a data security module, which may be part of the authentication module 106 and/or may decrypt the data before transmission to the additive manufacturing build material processing apparatus. In some examples, the data may be encrypted prior to

transmission, for example based on a session key established following authentication, or using a public key of the build material processing apparatus.

[0029] In some examples, at least some portions of the memory 102 are writable. In such examples, the communications interface 104 may be arranged to receive data relating to at least one of the plurality of additive manufacturing parameters from the additive manufacturing build material processing apparatus and to write the data to the memory 102. As set out in greater detail herein after, in some examples, at least some data fields of the memory 102 may be associated with a condition. In such examples, the data to be written to the memory 102 may be associated with a validity check. For example, it may be case that a certain data field relates to the volume of build material in a container, and the container is not to be refilled. In such an example, it may be that field may be decremented, i.e. the value held therein may reduce, but not increase. In such an example, a processing module, which may be a processing module of the processing circuitry 100, may verify that the data meets the criteria before allowing the data field to be overwritten.

[0030] In some examples, certain data fields may be written to 'read-only' data fields. This can be a function of the memory 102 itself (i.e. there may be no way of rewriting the memory) or may be controlled by a processing module. Other data fields may be rewritten once, or until the data field is locked (for example, to identify the build material processing apparatus which uses the build material associated therewith), and thereafter become read-only data fields. Other data fields may be read and written to on several occasions. Other data fields may be associated with a token, for example comprising one or more bits which may be flipped from a 0 to a 1. In some examples, the token may be changed a maximum of once. In some examples, the authentication module 106 may verify at least one of the additive manufacturing build material processing apparatus and the data content (i.e. whether it complies with at least one data format or condition, such as being larger or smaller than the data currently recorded for that field) prior to writing the data to the memory.

[0031] In some examples (and/or in some circumstances), the memory 102 may be written with data to the effect that the processing circuitry 100 will not authorise a subsequent read operation and/or build material processing operation. For example, data may be written to the effect that the build material is exhausted, for example, a

field relating to the volume of the build material may be set to zero, or empty. In another example, a key used for authentication may be overwritten or deleted such that the build material can no longer be authenticated. In another example, the memory 102 may be cleared or overwritten (for example scrambled), or a flag may be set indicating that the data has been accessed.

[0032] Such measures may mean that the processing circuitry 100 is prevented from providing a subsequent authorisation to print after having provided a first authorisation to print. This may for example be useful in preventing an attempt to circumvent the security provided by the processing circuitry 100 by reusing the processing circuitry 100 with build material from multiple containers. Unless a preventative measure is taken, this could result in false authorisation of build material. However, by taking action to prevent reuse of the processing circuitry 100, the risks of such circumvention are reduced.

[0033] In other examples, at least a portion of the memory 102 could be written or rewritten with parameters 'on the fly', i.e. parameters may be generated for substantially immediate transmission to additive manufacturing build material processing apparatus. For example, a volume of build material may be determined based on a measurement of a volume or weight of build material in the container made in response to a request for parameters, passed to memory (for example on a transient basis) and transmitted to an additive manufacturing build material processing apparatus. In such examples, the memory 102 may comprise, at least in part, a transient memory, an 'overlay' memory, a data cache and/or a memory buffer, or the like, in which parameters are stored on a short term basis. However, such parameters may also be generated following a request and stored in a persistent manner, or until over-written.

[0034] The memory 102 may store additive manufacturing parameters. For example, these may comprise build material identification data. For example, this may comprise an identification of the material, class of material, particle size, range of particle sizes, origin (for example, supplier, country of origin, factory of origin or the like).

[0035] In some examples, the additive manufacturing parameters may comprise build material processing parameters, for example temperatures, speeds or other conditions of processing.

[0036] In some examples, the additive manufacturing parameters may comprise compatible build material identification data. "Compatible" may mean that the build materials can be mixed and an object successfully (and/or safely) generated therefrom. For example, compatible build material identification data may be explicit, comprising a list of materials with which the build material is, and/or is not compatible. For example, a particular plastic build material may be compatible with itself and a range of other plastic build materials. However, it could be incompatible with another plastic, or with a different material such as a rubber. In some examples, a build material may be compatible, or belong to, at least one compatible 'family' of materials, which may be explicitly identified. Providing a list in this manner may allow an additive manufacturing processing apparatus to learn the compatibility of new build materials.

[0037] In some examples, a mixture may be formed deliberately. For example, an object may be generated from build material comprising a proportion of build material from a plurality of sources, which may include at least one source build material container and/or at least one recycled build material source. However, in other examples, at least one build material may be present in small amounts, for example trace amounts may remain in an apparatus from a previous processing activity.

[0038] In some examples, were incompatible build materials to be mixed, this could represent a significant risk to an operator or apparatus. For example, incorrectly mixed build materials could catch on fire or create an adverse chemical reaction or the like. Therefore, ensuring that build materials are compatible by reference to an authorised data source may, in some cases, be a safety critical aspect of additive manufacturing. In some examples, compatibility may be checked prior to an apparatus receiving a build material. This may prevent contamination of an apparatus with non-compatible build materials, and/or may prevent potentially dangerous mixes being formed.

[0039] In some examples, the parameters may comprise mixing percentage ranges, for example a maximum or minimum proportion of recycled build material, or build material of a particular type, or the like. In additive manufacturing, it may be the case that selected portions of a plurality of layers of build material are solidified. The

unsolidified material may be recycled in subsequent build cycles. However, the behaviour of such material can be altered. For example, it may contain an amount of print agent such as a fusing agent, and/or the processes to which it has been subjected may alter some physical properties. Therefore, it may be the case that the proportion of recycled build material is controlled. In some examples, it may be that a mix of build material contains at least a threshold amount, for example 20%, of 'unused' powder to ensure the mixture as a whole behaves within intended parameters. The percentage may vary between build materials. Such a parameter may be used as a control input such that the intended mix ratios are achieved. In some examples, the number of generation cycles for which build material has been, or may be, used may be stored as a parameter.

[0040] In some examples, the parameters may be indicative of at least one, or any combination of the following parameters (with example units), each for example being stored in a memory field.

Name	Units
Peak Temperature of Melting	°C
Onset temperature of Melting Peak	°C
Extrapolated onset temperature of Melting Peak	°C
Onset temperature of Melting Peak	°C
Melting Enthalpy	KJ/Kg
Peak temperature of Recrystallization	°C
Onset temperature of Recrystallization Peak	°C
Extrapolated Onset temperature of Recrystallization Peak	°C
Glass Transition Temperature	°C
Vicat Softening Temperature	°C
Absorption coefficient @ 1500°K color temperature	%
Absorption coefficient @ 3000°K color temperature	%
Color (yellow index)	Index

Emissivity coefficient at Melt Temperature	%
Particle size - 10 percentile	um
Particle size - 50 percentile	um
Particle size - 90 percentile	um
Powder density (loose)	g/cm ³
Powder density (tapped)	g/cm ³
Melt flow index	cc / 10 min
Melt flow temperature	°C
Base Material Density	g/cm ³
Solution Viscosity	Number
Solution Viscosity (Solvent Name)	10 chars
Solution Viscosity (Solvent Temp)	°C
Base Material Specific Heat	KJ/(Kg K)
Compatible families (multiple occurrences)	10 chars
Thermal Conductivity	W/(m K)
Specific Heat	KJ/(Kg K)
Median Avalanche Angle @ ambient Temperature	Deg
Median Avalanche Angle @ spread Temperature	Deg
Material Flow Function Constant	g/cm ²
Material Flow Function Exponent	Number
Effective angle of Internal friction	Deg
Wall Friction	Number
White Powder Transmission depth at 2750K source	mm
Minimum Ignition Temperature dust cloud	°C

Minimum Ignition temperature powder layer	°C
Minimum Explosion Concentration	gr/m ³
Minimum ignition energy dust cloud	mJ
Dust Explosion Class	bar m/s
Max explosion pressure	bar
Combustion index	Number
Maximum recycled powder mix	%
Number of Generation cycles	Number
Water absorption	%

[0041] These example parameters include processing parameters, material flow parameters and safety parameters. Other example fields, which may be provided in any combination, may for example comprise a volume of build material in a container, origin of the build material (for example, a producer), an identifier of build material (for example, name, code, lot number or the like), a field to identify an apparatus which extracts the build material, build material history and the like.

[0042] In some examples, the additive manufacturing parameters may be stored in the memory as a compressed XML file. For example, such a file may be an indexed file, and the date may be recoverable by a reader with access to a dictionary. In other examples, XML compressors such as XMill, XGRind, Xpress, XComp or the like may be used.

[0043] Figures 2A and 2B show different views of an example of a data unit 200 comprising processing circuitry 100' arranged on a mounting 202. The data unit 200 may be a portable and/or standalone data unit 200, for example being readily transportable by hand. The mounting 202 comprises a circuitry region 204 to receive circuitry, a registration portion 206 and a retaining feature 208. The processing circuitry 100', which comprises a memory, is mounted on the circuitry region 204.

[0044] The data unit mounting 202 is to removably mount the processing circuitry 100' on a receiving portion of an additive manufacturing build material container, wherein the registration portion 206 is to be received in a corresponding guide portion of the receiving portion of the additive manufacturing build material

container, the retaining feature is to prevent removal of the data unit 200 from the receiving portion unless deformed, wherein the deformation of the retaining feature 208 to effect removal of the data unit from the receiving portion is a permanent deformation. For example, the retaining feature 208 may be permanently deformed by a plastic deformation, which may include snapping or breaking of the feature. As described herein after, a data unit 200 may be provided to provide authorisation for object manufacture and/or data describing build materials.

[0045] Such a mounting 202 allows a data unit 200 to be removably mounted on a build material container, meaning it may be either read in situ on a build material container, or removed therefrom for reading. For example, when in situ on the build material container, it may be read using a reader which is brought into proximity therewith. In some examples, the reader may be provided in a build material extraction element, such as an aspiration tube. However, as the data unit 200 may be removed from the build material container, it may be communicably coupled with other reader apparatus. For example, the data unit could be placed in a reader slot or drive, or brought into proximity with a proximity reader or the like. This means that the content of the data unit may be accessed in different ways and by different apparatus, which in turn eases the specifications for an end user to have a particular reader apparatus.

[0046] To consider an example in which a reader is provided in an extraction element such as an aspiration tube and is intended to communicate with the data unit in situ, this allows for ease of handling of the build material and for transfer of information from the data unit. However, it may be the case that additive manufacturing apparatus could be operated in the absence of such an extraction element. In that case, as the data unit 200 is arranged to be removably mounted, it may be removed therefrom and read in an alternative fashion. This increases the options for accessing the data thereon (which, as noted above, may enhance safety by correctly identifying build materials or attributes thereof, or providing authentication of the source of the build material and/or data content). For example, a user could convey a data unit 200 to alternative reader apparatus, such as a card slot on an additive manufacturing apparatus.

[0047] It may also be noted that build material containers may be bulky, and the contents thereof may be relatively costly. By providing a separable data unit 200, the

whole container need not be moved to access the data in some examples, and a faulty data unit 200 may be replaced with replacing the entire build material container (and in some examples, its content).

[0048] The retaining feature 208 may be plastically deformable, i.e. deformation thereof is at least partially irreversible. There may be some elastic deformation of the retaining feature 208, but beyond a threshold stress (which may be less than the pressure applied remove a data unit from the build material container), the deformation will be permanent (for example, the retaining feature 208 may snap or break) or otherwise apparent from inspection of the mounting 202. This may reduce the reusability of a data unit 200, and may provide a tamper evident feature.

[0049] The data unit mounting 202 may be a plastic, monolithic component. As such, it may be a relatively low cost component. The data unit mounting 202 may comprise, in whole or in part, a conductive plastic material. In order to prevent a build-up of static energy, conductive components may be used to couple the build material container to other apparatus. Providing a conductive mounting 202 contributes to the electrical coupling. In other examples, non-conductive mountings may be provided. In some examples, the mounting 202 may be conductive, but comprise a different material, such as an electrically insulating plastic bearing metal tracks, or be formed of metal or the like. By providing a separable mounting 202, the conductive properties of a data unit may be designed separately to the conductive properties of any other aspect of the build material container, which may reduce compromise in design. For example, in order to function with particular read apparatus (for example, to mitigate interference or the like), it may be that any circuitry may be electrically isolated by providing an electrically isolating mounting 202. Therefore, in some examples, the mounting 202 may comprise a different material, or have different material properties, to a build material container in which it is mounted.

[0050] The processing circuitry 100' comprises a memory 210 storing a plurality of additive manufacturing parameters, a communications interface 212, an authentication module 214 to provide an authentication response to an authentication request and a data security module 216 to decrypt data held in the memory 210. In some examples, the data security module 216 may also encrypt data to be written to the memory 210. In this example, the circuitry region 204 comprises a portion of the

data unit mounting 202 which is recessed within a face thereof. This allows the memory 210 to be at least partially embedded within the width of the mounting 202, providing protection thereof. In this example, as can be best seen in Figure 2b, the processing circuitry 100' at least partially protrudes from the face, which may facilitate electrical connection with a reader apparatus.

[0051] The memory 210 may for example comprise any of the features discussed in relation to memory 102 above and may store a plurality of additive manufacturing parameters. The additive manufacturing parameters stored in the memory 210 may comprise authentication data. The authentication data may be for use in authentication of the build material and/or the data stored in the memory. In some examples, the authentication data may allow the data unit 200 to authenticate other apparatus or data sources, for example an additive manufacturing build material apparatus with which it is in communication. For example, the memory 210 may be provided with a key, or a password, for use in authentication.

[0052] The additive manufacturing parameters stored in the memory 210 may comprise build material identification data. For example, this may comprise an identification of the material, class of material, particle size, range of particle sizes, origin (for example, supplier, country of origin, factory of origin or the like).

[0053] In some examples, the additive manufacturing parameters may comprise build material processing parameters, for example temperatures, speeds or other conditions of processing.

[0054] The communications interface 212 is arranged to communicate with a reader of an additive manufacturing build material processing apparatus, which may for example comprise an additive manufacturing apparatus (or '3D printer') and/or a build material treatment apparatus and in this example, comprises a galvanic interface, i.e. an electrical connection is made over which data may be sent or received. However, the communications interface 212 may have any of the features described in relation to communications interface 104 above.

[0055] The authentication module 214 in this example comprises at least one processor and is arranged to receive an authentication request from an additive manufacturing build material processing apparatus (for example, received via the communications interface 212) and to provide an authentication response for

communication to the additive manufacturing build material processing apparatus. This authentication is based on an additive manufacturing parameter stored in the memory 210, for example a cryptographic secret code or password of the like.

[0056] The authentication module 214 may have any of the features discussed in relation to authentication module 106 above.

[0057] In some examples, at least some portions of the memory 210 are writable. In some such examples, the communications interface 212 may be arranged to receive data and to write the data to the memory 210. For example, this may be data relating to at least one of the plurality of additive manufacturing parameters. In some examples, at least some data fields of the memory may be associated with a condition, as discussed above. In some examples, a volume of build material extracted from a container may be reflected in a field of the memory 210. For example, build material may be removed from a container in a metered manner, and the amount removed and/or the amount remaining may be recorded in the memory 210. In such examples, the data to be written to the memory may be associated with a validity check. In other examples, locally generated data, for example determined by a processor of the processing circuitry 100' may be written the memory 210.

[0058] The data security module 216 may decrypt encrypted data before transmission to an additive manufacturing build material processing apparatus. In some examples, the data may be (re)encrypted by the data security module 216 prior to transmission, for example based on a session key established following authentication, or using a public key of the build material processing apparatus.

[0059] The data unit mounting 202 comprises a first planar portion 218 and a second planar portion 220, the planar portions 218, 220 being substantially orthogonal. In this example, the planar portions 218, 220 are connected substantially along a shared edge. The circuitry region 204 and the registration portion 206 are on the first planar portion 218, and the retaining feature 208 is provided on the second planar portion 220. By providing the circuitry region 204 and the retaining feature 208 on different planar portions 220, the circuitry region 204 may to some extent be protected from pressure applied to deform the retaining feature 208. In addition, the second planar portion may provide a 'stop' surface when the first planar portion is

inserted into a reader, and may ensure that the data unit 200 at least partially remains outside such a reader.

[0060] It may be noted that, in this example, the retaining feature 208 has a first cross sectional thickness and the planar portions 218, 220 have a second, greater thickness. This may enhance the chances that the retaining feature 208 will flex, deform or break before the planar portions 218, 220. In some examples, there may be other features which serve to stiffen and/or strengthen the planar portions 218, 220 relative to the retaining feature 208. For example, they may comprise strengthening ribs, or be formed of a different material, or the like.

[0061] In some examples, the mounting 202 may be configured such that a user may deform, or break, the retaining feature 208 without a mechanical advantage or a tool. This may allow tool-less insertion and/or removal of the mounting 202.

[0062] The second planar portion 220 also comprises a compressible element 224, in this example comprising a pair of extending arms 226a, 226b which extend at an angle to the body of the second planar portion 220. The arms 226a, 226b can be flexed back towards the body of the second planar portion 220. The maximal longitudinal length of the second planar portion 220 is defined by the positions of the arms 226a, 226b. When the arms are flexed towards the body of the second planar portion 220, the compressible element 224 is compressed and this reduces the longitudinal dimension of the second planar portion 220. However, this dimension could be reduced in some other way, for example by providing a telescoping portion, or a concertina portion, a sprung portion, a deformable portion, or the like and therefore this is just one example of a compressible element 224. In some examples, the mounting 202 may be configured such that a user may compress the compressible element 224 without a mechanical advantage or a tool. This may allow tool-less insertion of the mounting 202. For example, the dimension may be reduced to allow the data unit 200 to pass through an opening, and then the arms 226 may return to their initial position and the data unit 200 may be retained within the opening.

[0063] The second planar portion 220 also comprises a handling portion 222, in this example a tab which extends from a central region of the second planar portion 220. In this example, the handling portion 222 extends substantially orthogonally from the second planar portion, in a plane which is substantially parallel

to the plane of the first planar portion 218. This means that the handling portion 222 may remain accessible when the data unit 200 is inserted into a build material container and/or reader, and may be acted upon to remove the data unit 200 from build material container and/or reader. The presence of the handling portion 222 may also prevent excessive handling of the circuitry (the memory 210, communications interface 212 and the like), which may be relatively delicate.

[0064] The data unit 200 may for example comprise a 'smart card'. In one example, the second planar portion 220 has dimensions corresponding to the dimensions of a Universal Integrated Circuit Card (UICC), also termed a subscriber identity module, or SIM card. For example, the second planar portion may have the dimensions of a SIM, MicroSIM or NanoSIM card. This allows the data unit 200 to be used with standard card reading apparatus.

[0065] Figure 3 shows an example of a build material container 300 comprising processing circuitry 100', in this example, a data unit 200. In this example, the processing circuitry 100' is situated in the region of an opening 302 in the container 300, in particular in a neck thereof. The build material container 300 further comprises a storage volume 304 to contain additive manufacturing build material.

[0066] In one example the container 300 may contain a source supply of fresh build material. In another example the container 300 is a source supply of recycled or partly recycled build material. In yet another example the container 300 may be used, at least temporarily, as a buffer supply.

[0067] The storage volume 304 may comprise a reservoir to hold build material. In some examples, the storage volume may include an upper upright section having relatively upright side walls, at least in a filled state, along most of the height of the reservoir, a lower funnel having converging side walls; and a build material outlet structure providing the opening to allow build material to exit the reservoir.

[0068] The outlet structure may comprise a retaining structure to maintain a connection to a connecting build material extraction element such as an aspiration tube which may be used to draw build material from the reservoir in to a build material processing apparatus.

[0069] For example, the outlet structure may comprise an adaptor to guide an external aspiration system in connection with the outlet structure, the adaptor

comprising an interface face around its outlet opening, the interface face extending perpendicular to an aspiration direction, and a standing circumferential wall within which an aspiration tube is to be inserted to engage the interface face. The outlet structure may include a collect structure to collect build material from the bottom and guide the build material to an outlet opening at the top. For example, this may be a tube (which may be rigid tube) which extends to the lower portions of the reservoir. The reservoir may comprise, or be lined with, a flexible material such that, when build material is removed therefrom (for example under a negative pressure), the volume of the reservoir may decrease. The reservoir may be contained in a rigid or semi rigid supporting structure which does not deform.

[0070] In some examples, the processing circuitry 100' may be arranged in the opening such that when an extraction element is attached thereto, a reader in the extraction element may read the processing circuitry 100'. In some examples, the extraction element may be at least temporarily attached to the opening based on its orientation (e.g., there may be a locked or fixed orientation and unlocked orientation). In such examples, the locked orientation may be an orientation in which the reader is proximate to, or interlinked with, the authentication chip.

[0071] Although in this example, the processing circuitry may be placed in contact with a reader, in other examples, the processing circuitry 100' may comprise, for example, a Radio Frequency Identification (RFID) tag, or may communicate using Near Field Communications (NFC), or comprise a wired communications link, or the like.

[0072] Figure 4 is a method comprising, in block 402, acquiring a plurality of parameters associated with an additive manufacturing build material. The parameters may comprise at least one of build material identification data, build material processing parameter parameters and compatible build material identification data.

[0073] Block 404 comprises writing the parameters to a memory of an authentication chip (which may for example comprise processing circuitry 100, 100'). Block 406 comprises acquiring an authentication code, which may for example comprise a cryptographic key, or a seed for generating such a key. Block 408 comprises providing, on the chip, an authentication module to provide authentication of the data on request by an additive manufacturing apparatus, the authentication

module being to provide an authentication response based on the authentication code. The authentication module may comprise a processor or processing circuitry. In some examples, the method of Figure 4 may comprise a method of manufacture of processing circuitry 100, 100', and may therefore comprise providing any feature described above in relation to the processing circuitry.

[0074] In some examples, the method may further comprise attaching the chip to a build material container, for example a build container 300 as shown in Figure 3. The build material container may contain build material described in the parameters.

[0075] Figure 5 is an example of a method comprising, in block 502, transmitting, from a data source associated with a build material to an additive manufacturing build material processing apparatus, a build material processing authorization, wherein the validity of the authorization is verifiable by the additive manufacturing build material processing apparatus. The data source may comprise processing circuitry 100 as shown in Figure 1, or a data unit 200, for example as shown in Figure 2, or an authentication chip, as may be produced by the method of Figure 4. In some examples, the data source may be provided as part of a transfer vessel, for example in a memory thereof. For example, it may be the case that the build material is processed (for example, mixed with other sources of build material) in a first apparatus, transferred to a transfer vessel and transported to a second apparatus for object generation. The data source may be provided on the transfer vessel, for example in a memory thereof.

[0076] Block 504 comprises transmitting, from the data source associated with a build material to an additive manufacturing build material processing apparatus, at least one additive manufacturing build material processing parameter. For example, this may specify compatible materials and/or material mixing proportions, or may specify manufacturing parameters such as processing temperatures. By providing build material processing parameters, the additive manufacturing build material processing apparatus may be provided in some examples with new operating conditions or information about new build materials. Thus, in some examples, the additive manufacturing build material processing apparatus may be in effect upgraded or updated by the data on the data source.

[0077] In block 506, the build material is processed by the additive manufacturing material processing apparatus according to the transmitted at least one additive manufacturing build material processing parameter. For example, at least one parameters may be used as or in a control input to the apparatus. For example, an additive manufacturing apparatus may configure heating apparatus to provide a temperature as specified in the parameters, or a mixing apparatus may mix build materials according to ratios specified in the parameters, or the like. In some examples, if the data source is not verified, the build material may be refused before being processed or accepted, or processing thereof may be halted before damage to apparatus and/or potentially hazardous situations arise.

[0078] In some examples, at least one additive manufacturing parameter comprises a compatibility indicator. In such examples, the processing of the build material may be dependent on whether the build material is to combined with at least one other build material, and, if so, whether the build materials are compatible according to the compatibility indicator. In other examples, the compatibility indicator may indicate compatible apparatus, and the processing of the build material may be dependent on whether the build material is compatible with an apparatus which is intended to process the build material (or that apparatus in a particular state) As such, contamination of additive manufacturing build material processing apparatus with either unauthorised, inappropriate or incompatible build materials may be prevented.

[0079] Figure 6 is an example of a method of providing additive manufacturing apparatus with a print authorisation.

[0080] Block 602 comprises transmitting, from a data source associated with a build material to an additive manufacturing build material processing apparatus, in this example, a pre-treatment apparatus, a build material processing authorization, wherein the validity of the authorization is verifiable by the additive manufacturing build material processing apparatus. In one example, the data source comprises processing circuitry 100, 100', or for example a data unit 200 for example as shown in Figure 2.

[0081] Block 604 comprises transmitting, from the data source associated with a build material to the additive manufacturing build material pre-treatment apparatus, at least one additive manufacturing build material processing parameter comprising a

compatibility indication. For example, this may comprise a list of other build materials with which the build material described thereby may be safely mixed. In some examples additional parameters, for example, specifying manufacturing parameters such as processing temperatures, may be provided. The pre-treatment apparatus may for example comprise a mixing and/or preparation apparatus to mix build material from a plurality of sources (some of which may include recycled materials), or may condition the build material for use, and/or may convey the build material to a transfer vessel. Conditioning the build material for use may for example comprise sieving build material, which may remove caked powder portions within build material or contaminants (for example, in the case recycled powder, fused material which may have been fused accidentally, or may comprise broken object parts). The pre-treatment apparatus may also condition the build material by mixing build material from more than one source, for example, mixing recycled and new build material. The pre-treatment apparatus may comprise or be coupled with two or more storage vessels, for example, a first storage vessel comprising mixed material and another for storing used build material for recycling (which may comprise a transfer vessel, as discussed below).

[0082] Block 606 comprises verifying the validity of the authorisation provided from the data source by the additive manufacturing build material pre-treatment apparatus. If the verification is successful, in block 608 the compatibility indication is checked. This may for example be checked to ensure that build materials from multiple sources are compatible, or that the pre-treatment apparatus is in a state to receive the build material described by the parameters. If the build material is compatible, in block 610, the build material transferred to the pre-treatment apparatus, and is processed thereby (for example, being mixed with other build materials). In some examples, the pre-treatment apparatus may mix build materials and the parameters may comprise an indication of mixing ratios. In such examples, the mixing ratio may be used to control the pre-treatment apparatus to mix the build materials according to the ratio. If not, in some examples, the build material may be refused, a cleaning cycle may be conducted, or at least one other build material may be changed for a compatible build material.

[0083] In block 612, the build material, having been processed by the pre-treatment apparatus, is transferred to a transfer vessel, which may for example (as described below in relation to Figure 7) comprise a container or trolley, and which comprises a memory. Data relating to the build material and based on at least one parameter received from the data source is transferred to a memory of the transfer vessel in block 614. In some examples, the pre-treatment apparatus may mix build materials. In such examples, the data transferred to the memory of the transfer vessel may comprise data relating to more than one build material. In some examples, the data transferred to the memory of the transfer vessel may comprise, for example, any or any combination of mix ratio, build material history (for example, the number of time build material has been recycled), an identification of the pre-treatment apparatus, or the like. In some examples, status data relating to the status of the pre-treatment apparatus may be overwritten. For example, it may be noted the pre-treatment apparatus has received an identified build material type and this information may be stored by the pre-treatment apparatus (for example in a memory thereof) such that the compatibility of future build material supplies (for example before cleaning of the apparatus) can be assessed

[0084] In block 616, the transfer vessel is coupled to an additive manufacturing apparatus. The data from the memory is transferred to the additive manufacturing apparatus in block 618, and the additive manufacturing apparatus processes the build material based on the data in block 620. In some examples, based on the transferred data, build processes may be implemented or overwritten. For example, the data may specify build temperatures, or may identify a material to allow temperatures or other conditions to be derived therefrom. In some examples, status data relating to the status of an additive manufacturing apparatus may be overwritten. For example, it may be noted the apparatus has received an identified build material type and this information may be stored on the additive manufacturing apparatus (for example in a memory thereof) such that the compatibility of future build material supplies (for example before cleaning of the apparatus) can be assessed.

[0085] In some examples, the pre-treatment apparatus may be arranged provide an authentication of the data transferred to the transfer vessel, for example by encrypting or digitally signing the data. The additive manufacturing apparatus may

verify the authenticity of the data received. In some examples, this verification may serve to unlock or release at least one additive manufacturing process of the additive manufacturing apparatus.

[0086] Thus, in the example of Figure 6, the additive manufacturing apparatus may be provided with an authorisation and/or additive manufacturing data via the transfer vessel, which may itself acquire data from a pre-treatment apparatus. As such, the parameters and/or the (at least implicit) authorisation travel with the build material to which they pertain, providing for ease of use and/or security enhancements as the parameters/authorisation may be consistently associated with the correct build material.

[0087] Figure 7 is an example of a transfer vessel 700 for additive manufacturing build material, the transfer vessel being to receive build material from a first additive manufacturing build material processing apparatus (for example, in a storage volume thereof) and to provide build material to a second additive manufacturing build material processing apparatus. The transfer vessel 700 comprises a memory 702 to receive data relating to the build material from the first additive manufacturing build material treatment apparatus and to provide data to the second additive manufacturing build material processing apparatus. For example, the transfer vessel may transfer data between a pre-treatment apparatus and an additive manufacturing apparatus, or between a post-manufacture apparatus, which may extract unfused build material for recycling, and a pre-treatment apparatus, which prepares the build material for reuse, or the like. The data may be stored in the memory in a secure or validated format, for example being encrypted and/or digitally signed. The data may for example comprise additive manufacturing parameters, which may include any of the parameters mentioned above, including processing parameters, build material parameters, mix ratios, build material history, and the like. As the data may be transferred with the build material, this may provide a convenient data transfer method, in which data remains physically associated with build material to which it pertains.

[0088] In some examples, the transfer vessel 700 may be a wheeled container or trolley. The transfer vessel 700 may for example comprise a print bed on which an object may be generated by an additive manufacturing apparatus. The transfer vessel 700 may comprise an interface and may be arranged to transfer data to or from

an additive manufacturing build material processing apparatus via the interface. In some examples, the data transfer may occur when the transfer vessel 700 is in a position to receive build material from or provide build material to an additive manufacturing build material processing apparatus. For example, the interface may be arranged to communicate with the additive manufacturing build material processing apparatus when in a position to receive build material from or provide build material to the additive manufacturing build material processing apparatus. The data may for example be transferred via a wired or galvanic connection, or wirelessly.

[0089] Figure 8 shows an additive manufacturing materials processing unit 800 comprising an interface 802, a release mechanism 804 and a validation module 806. The interface 802 is arranged to receive data from a data source associated with a build material. This data may for example be received over a wired or galvanic connection or wirelessly (for example, using optical or radio data transmission methods). The release mechanism 804, which may be a physical release mechanism or control circuitry provided by a processor or the like, is arranged to prevent at least one operation of the additive manufacturing materials processing unit 800 in the absence of a release code. The validation module 806 is arranged to validate the data source and to request, from the data source, at least one compatibility indicator of the build material. The validation module 806 is further arranged to, based on the compatibility indicator, determine if the build material meets predetermined compatibility criteria and, if the data source is valid and the build material meets predetermined compatibility criteria; to generate a release code

[0090] The additive manufacturing materials processing unit 800 may for example comprise an additive manufacturing apparatus to generate an object from the build material. In such an example, the release mechanism 804 may be to prevent generation of an object in the absence of a release code.

[0091] In some examples, the additive manufacturing materials processing unit 800 may comprise a build material processing unit comprising an ingress port to receive a volume of the build material and in which the release mechanism is to prevent ingress of the build material in the absence of a release code. For example, such a processing unit may import build material under the action of a negative pressure or vacuum. However, in the event that the build material is not authorized,

or is not compatible with another build material (in some examples, at trace level), import of the build material may be prevented.

[0092] In some examples, therefore, if the build material is compatible (which may be compatible with other build material present and/or the compatible with the apparatus itself), the additive manufacturing materials processing unit 800 may accept the build material for processing (for example, allowing ingress of the build material into a treatment apparatus, or forming layers of the build material for object generation in an additive manufacturing apparatus). Otherwise, if the build material is determined not to be compatible, the additive manufacturing materials processing unit 800 may refuse the build material, and may for example display a non compatible message to a user thereof and/or commence a cleaning cycle (for example, if the non-compatibility is associated with residual build material from previous processing operations) or the like.

[0093] Figure 9 shows an example of an additive manufacturing materials processing unit 900 which comprises, in addition to the elements of Figure 8, a cleaning module 902 and a data reader 904. The data reader may read the data from a memory, in some examples the memory of processing circuitry 100. If it is determined that the build material does not meet predetermined compatibility specifications, the cleaning module 902 is to perform a cleaning operation. This may clean the additive manufacturing materials processing unit 900 such that it can be used with the build material associated with the data source.

[0094] Some aspects in the present disclosure can be provided as methods, systems or machine readable instructions, such as any combination of software, hardware, firmware or the like. Such machine readable instructions may be included on a computer readable storage medium (including but is not limited to disc storage, CD-ROM, optical storage, etc.) having computer readable program codes therein or thereon.

[0095] The present disclosure is described with reference to flow charts and/or block diagrams of the method, devices and systems according to examples of the present disclosure. Although the flow diagrams described above show a specific order of execution, the order of execution may differ from that which is depicted. Blocks described in relation to one flow chart may be combined with those of another flow

chart. It shall be understood that at least some flows and/or blocks in the flow charts and/or block diagrams, as well as combinations of the flows and/or diagrams in the flow charts and/or block diagrams can be realized by machine readable instructions.

[0096] The machine readable instructions may, for example, be executed by a general purpose computer, a special purpose computer, an embedded processor or processors of other programmable data processing devices to realize the functions described in the description and diagrams. In particular, a processor or processing apparatus may execute the machine readable instructions. Thus functional modules of the apparatus (such as the authentication module 106, validation module 806 or the like) may be implemented by a processor executing machine readable instructions stored in a memory, or a processor operating in accordance with instructions embedded in logic circuitry. The term 'processor' is to be interpreted broadly to include a CPU, processing unit, ASIC, logic unit, or programmable gate array etc. The methods and functional modules may all be performed by a single processor or divided amongst several processors.

[0097] Such machine readable instructions may also be stored in a computer readable storage that can guide the computer or other programmable data processing devices to operate in a specific mode.

[0098] Machine readable instructions may also be loaded onto a computer or other programmable data processing devices, so that the computer or other programmable data processing devices perform a series of operations to produce computer-implemented processing, thus the instructions executed on the computer or other programmable devices realize functions specified by flow(s) in the flow charts and/or block(s) in the block diagrams.

[0099] Further, the teachings herein may be implemented in the form of a computer software product, the computer software product being stored in a storage medium and comprising a plurality of instructions for making a computer device implement the methods recited in the examples of the present disclosure.

[00100] While the method, apparatus and related aspects have been described with reference to certain examples, various modifications, changes, omissions, and substitutions can be made without departing from the spirit of the present disclosure. It is intended, therefore, that the method, apparatus and related aspects be limited by

the scope of the following claims and their equivalents. It should be noted that the above-mentioned examples illustrate rather than limit what is described herein, and that those skilled in the art will be able to design many alternative implementations without departing from the scope of the appended claims. Features described in relation to one example may be combined with features of another example.

[00101] The word “comprising” does not exclude the presence of elements other than those listed in a claim, “a” or “an” does not exclude a plurality, and a single processor or other unit may fulfil the functions of several units recited in the claims.

[00102] The features of any dependent claim may be combined with the features of any of the independent claims or other dependent claims.

CLAIMS

What is claimed is:

1. Processing circuitry comprising:
 - a data source to provide a plurality of additive manufacturing parameters;
 - a communications interface to communicate with an additive manufacturing build material processing apparatus; and
 - an authentication module to:
 - receive an authentication request from an additive manufacturing build material processing apparatus; and
 - provide an authentication response for communication to the additive manufacturing build material processing apparatus,wherein the communications interface is to transmit data from the data source to the additive manufacturing build material processing apparatus.
2. Processing circuitry according to claim 1 in which the authentication module is to receive an authentication request comprising a message, to encrypt the message and in which the authentication response comprises the encrypted message.
3. Processing circuitry according to claim 1 or claim 2, in which the authentication module is to authenticate the additive manufacturing build material processing apparatus and, if the additive manufacturing build material processing apparatus is authenticated, to transmit data from the data source to the additive manufacturing build material processing apparatus.
4. Processing circuitry according to any preceding claim which comprises a data security module, and in which the data source comprises a memory which is to store the additive manufacturing parameters in an encrypted form, wherein the data security module is to decrypt the data before transmission to the additive manufacturing build material processing apparatus.

5. Processing circuitry according to any preceding claim in which the data source comprises a memory and the communications interface is to receive data relating to at least one of the plurality of additive manufacturing parameters from the additive manufacturing build material processing apparatus and to write the data to the memory.

6. Processing circuitry according to claim 5 in which the authentication module is to verify, prior to writing the data to the memory, at least one of the additive manufacturing build material processing apparatus and a data content.

7. Processing circuitry according to any preceding claim in which the authentication response comprises a release code for the additive manufacturing build material processing apparatus, the release code being to authorize at least one additive manufacturing process of the additive manufacturing build material processing apparatus.

8. Processing circuitry according to any preceding claim in which the data source comprises a memory, the memory storing at least one additive manufacturing parameter, the at least one additive manufacturing parameter comprising at least one of:

- build material identification data;
- a build material processing parameter; and
- compatible build material identification data.

9. Processing circuitry according to any preceding claim in which the data source comprises a memory, the memory storing additive manufacturing parameters as a compressed XML file.

10. Processing circuitry according to any preceding claim in which the data source comprises a memory, the memory comprising a plurality of memory fields, the memory fields comprising at least two of:

- a read only memory field;

a write once memory field; and
a read/write memory field.

11. Processing circuitry according to any preceding claim which is to be mounted on a build container.

12. A build material container comprising a data unit, the data unit comprising processing circuitry according to any of claims 1-11 and a storage volume to contain additive manufacturing build material.

13. A build material container according to claim 12 containing a build material.

14. A method comprising:
acquiring a plurality of parameters associated with an additive manufacturing build material, the parameters comprising at least one of build material identification data, build material processing parameter parameters and compatible build material identification data;
writing the parameters to a memory;
acquiring an authentication code; and
providing processing circuitry in communication with the memory, the processing circuitry comprising an authentication module to provide authentication of the parameters in the memory on request by an additive manufacturing apparatus, the authentication module being to provide an authentication response based on the authentication code.

15. A method according to claim 14 further comprising attaching the processing circuitry and the memory to a build material container.

16. A method comprising:
transmitting, from a data source associated with a build material to an additive manufacturing build material processing apparatus, a build material processing

authorization, wherein a validity of the build material processing authorization is verifiable by the additive manufacturing build material processing apparatus;

transmitting, from the data source associated with a build material to an additive manufacturing build material processing apparatus, at least one additive manufacturing build material processing parameter; and

processing of the build material by the additive manufacturing build material apparatus according to the transmitted at least one additive manufacturing build material processing parameter.

17. A method according to claim 16, wherein at least one additive manufacturing build material processing parameter comprises a compatibility indicator, and wherein the processing of the build material is dependent on whether the build material is to combined with at least one other build material.

18. A method according to claim 17, the method further comprising, if a verification of the build material processing authorization is successful:

checking the compatibility indicator, and, if the build material is compatible, transferring the build material to the additive manufacturing build material processing apparatus.

19. A method according to claim 18 further comprising:

transferring build material processed by the additive manufacturing build material processing apparatus to a transfer vessel; and

transferring data relating to the build material and based on at least one parameter received from the data source to a memory of the transfer vessel.

20. A method according to claim 19 further comprising coupling the transfer vessel to another additive manufacturing build material processing apparatus and transferring data from the memory to the additive manufacturing build material processing apparatus.

21. A transfer vessel for additive manufacturing build material, the transfer vessel being to receive build material from a first additive manufacturing build material processing apparatus and to provide build material to a second additive manufacturing build material processing apparatus,

the transfer vessel comprising a memory to receive data relating to the build material from the first additive manufacturing build material processing apparatus and to provide data to the second additive manufacturing build material processing apparatus.

22. An additive manufacturing materials processing unit comprising:
an interface to receive data from a data source associated with a build material;
a release mechanism to prevent at least one operation of the materials processing unit in the absence of a release code;

a validation module, wherein the validation module is to

- i. validate the data source;
- ii. request, from the data source, at least one compatibility indicator of the build material;
- iii. determine, based on the compatibility indicator, if the build material meets predetermined compatibility criteria;
- iv. and, if the data source is valid and the build material meets predetermined compatibility criteria, to generate a release code.

23. An additive manufacturing materials processing unit according to claim 22 which comprises an additive manufacturing apparatus to generate an object from the build material, and in which the release mechanism is to prevent generation of an object in the absence of a release code.

24. An additive manufacturing materials processing unit according to claim 22 or 23 which comprises a build material processing apparatus comprising an ingress port to receive a volume of the build material and in which the release mechanism is to prevent ingress of the build material in the absence of a release code.

25. An additive manufacturing materials processing unit according to any of claims 22 to 24 comprising a cleaning module, in which, if it is determined that the build material does not meet predetermined compatibility specifications, the cleaning module is to perform a cleaning operation.

1/5

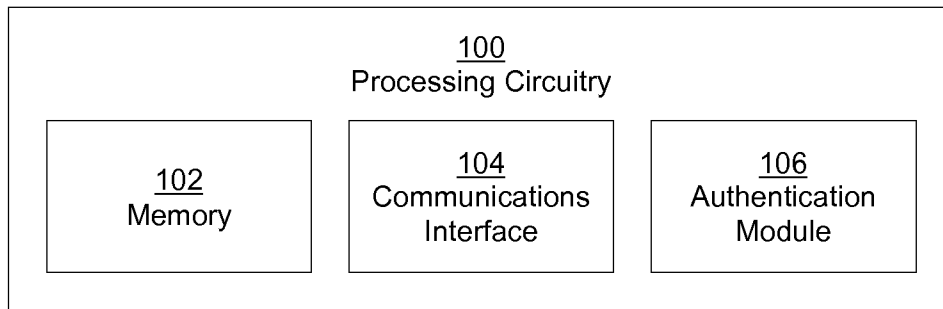


Fig. 1

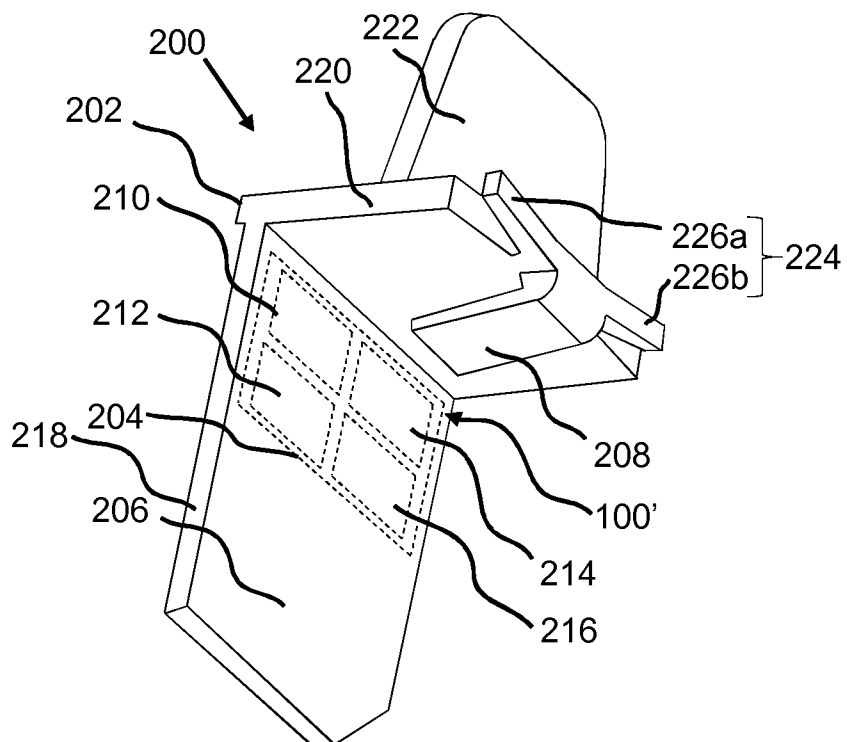


Fig. 2A

2/5

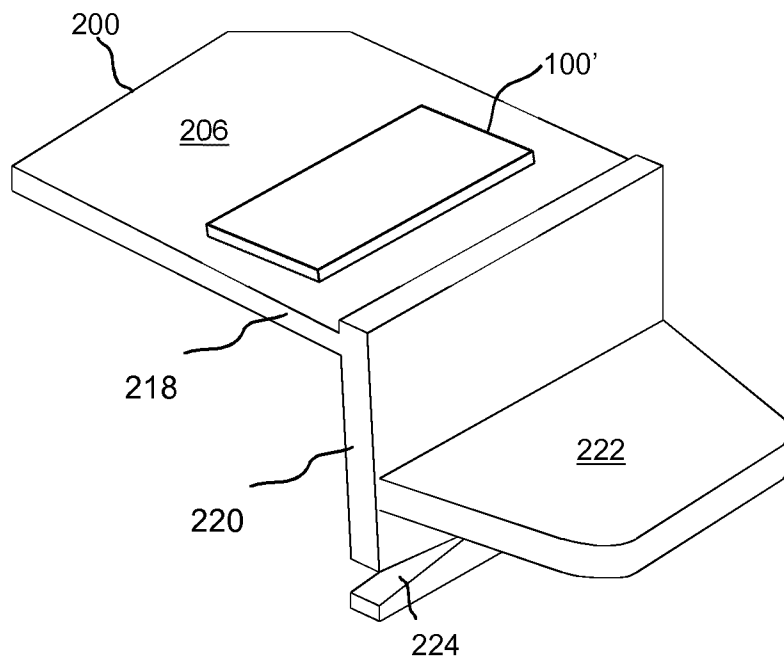


Fig. 2B

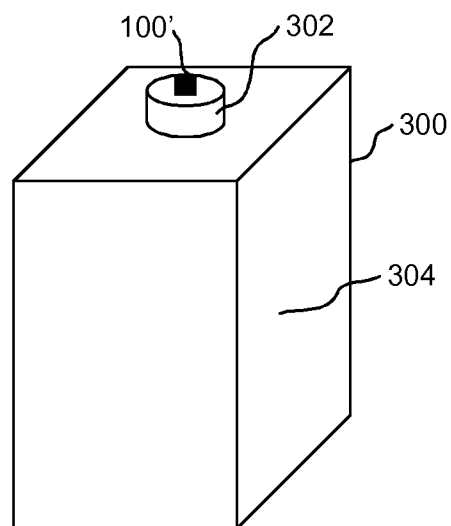


Fig. 3

3/5

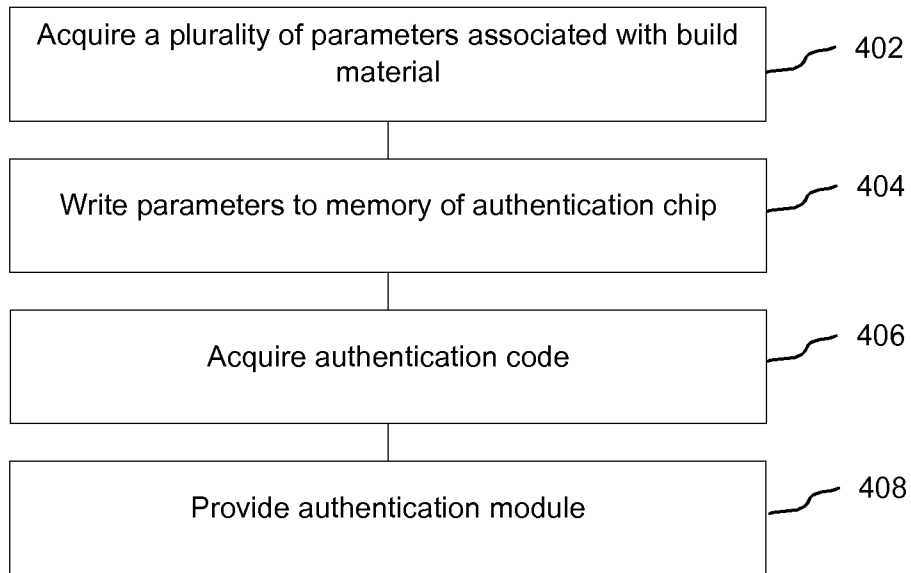


Fig. 4

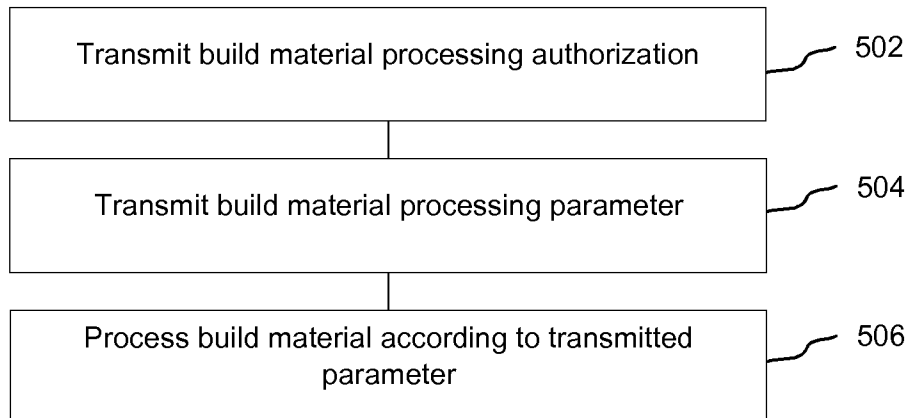


Fig. 5

4/5

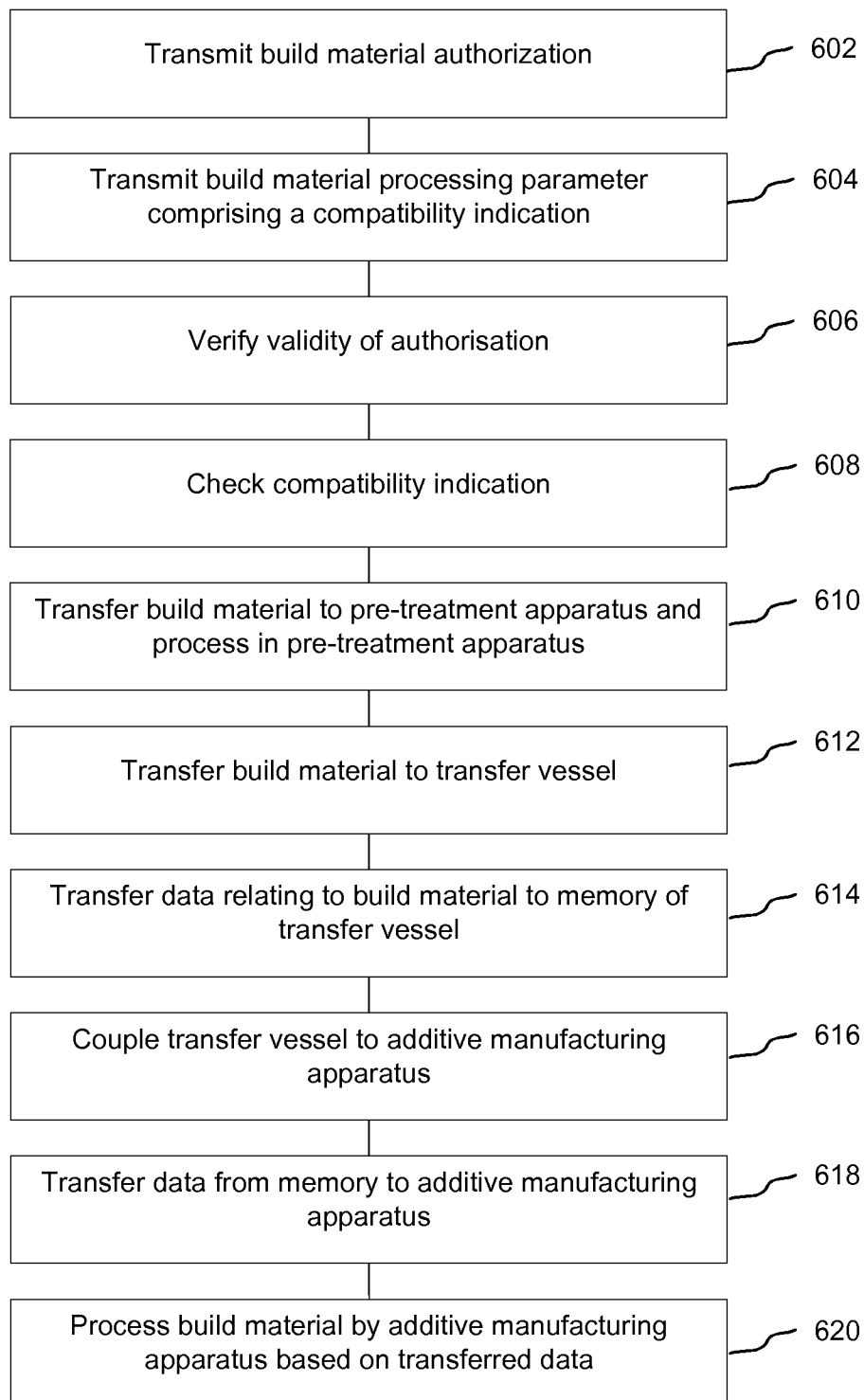


Fig. 6

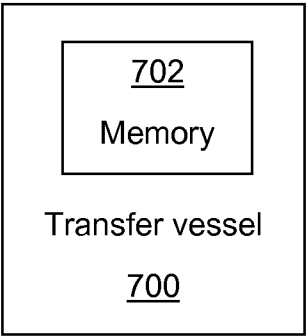


Fig. 7

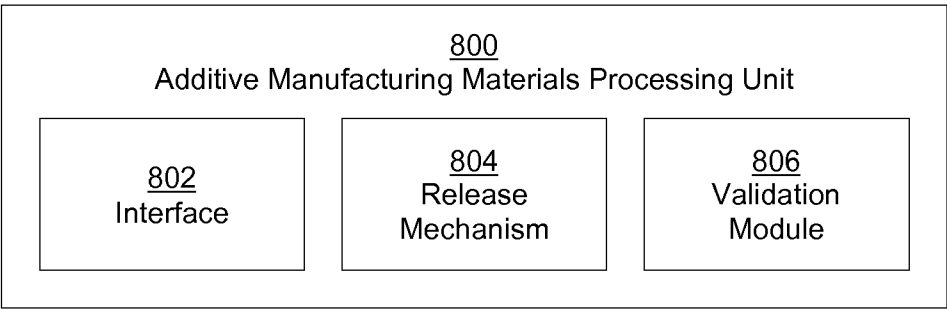


Fig. 8

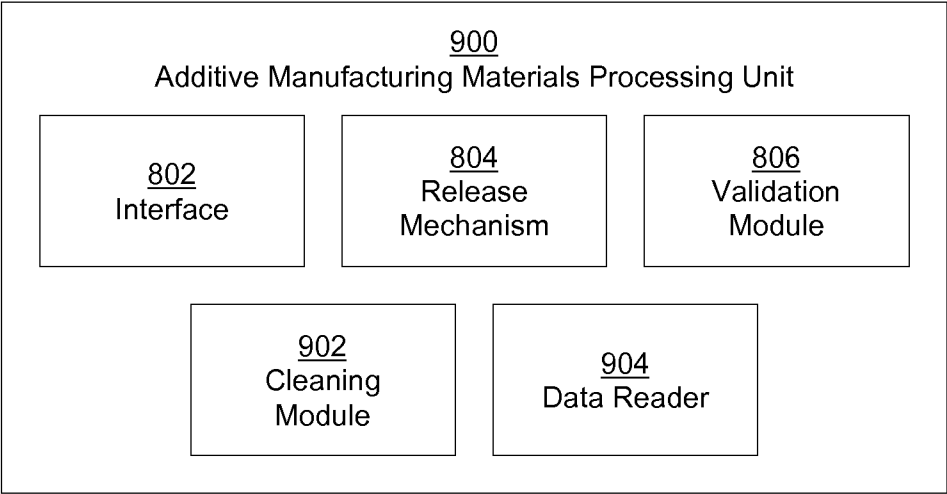


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060750

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L29/06 B33Y50/02 B29C47/00 B29C67/00 G05B19/4099
ADD.

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)

H04L B33Y B29C H04W G05B

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

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016/121550 A1 (DOUGLAS ARIEL [US] ET AL) 5 May 2016 (2016-05-05) paragraphs [0004], [0062], [0064] paragraphs [0068], [0070], [0071] paragraphs [0093], [0096] - [0098] -----	1-20, 22-25
A	US 2011/117268 A1 (BATCHELDER J SAMUEL [US] ET AL) 19 May 2011 (2011-05-19) paragraphs [0015], [0029], [0031] -----	1-20, 22-25
A	US 2014/265047 A1 (BURRIS MATTHEW [US] ET AL) 18 September 2014 (2014-09-18) paragraphs [0067] - [0070] -----	1-20, 22-25
A	WO 2016/019064 A1 (MASTER LOCK CO [US]) 4 February 2016 (2016-02-04) paragraphs [0011], [0038], [0040] paragraph [0094] -----	1-20, 22-25

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 January 2017

Date of mailing of the international search report

10/03/2017

Name and mailing address of the ISA/

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Authorized officer

Kufer, Léna

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/060750

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-20, 22-25

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-20, 22-25

Methods and apparatuses for additive manufacturing
authentication and authorisation

2. claim: 21

Transfer vessel for additive manufacturing build material

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/060750

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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