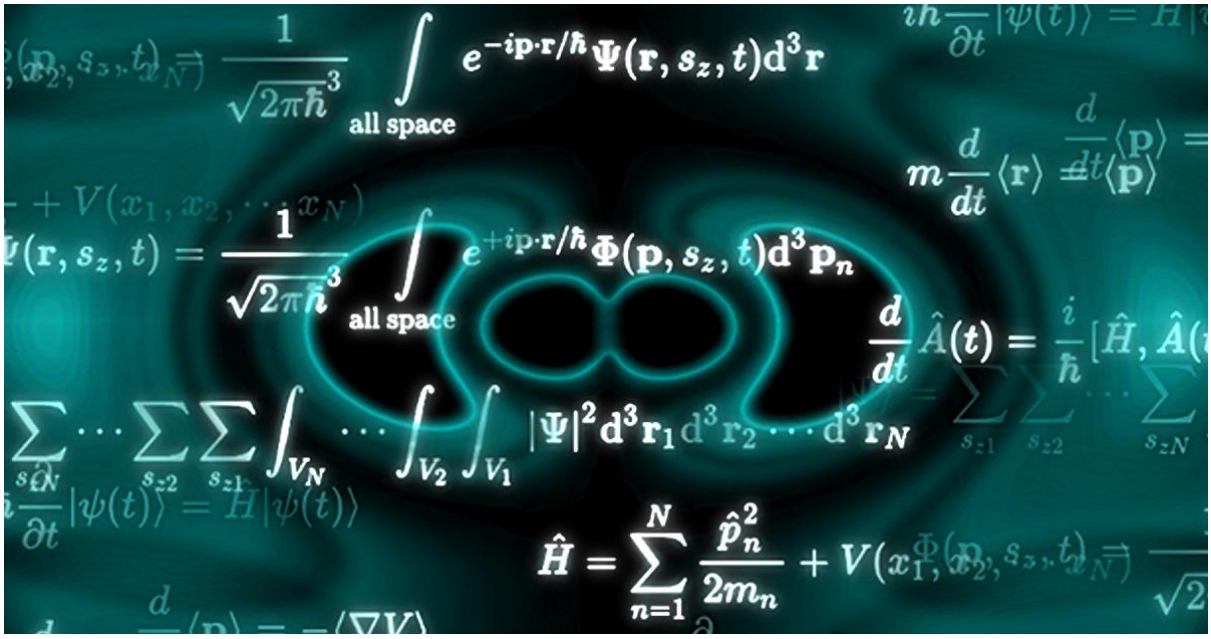

Patent protection in the field of quantum computing

Headline: Quantum computing is happening (also in the IP space). Inventions in this field can easily be a headache for patent professionals, as they often cheerfully combine concepts from materials science, electronics, electromagnetism, thermodynamics, and quantum physics. Here are a few aspects to consider when drafting patent claims.

"It is difficult to make predictions, particularly about the future." This comical observation would be nothing but a truism if it weren't for the word "particularly". However, it resonates differently in the ears of quantum physicists, who may understand it as an imperfect statement. The reason is that uncertainty principles in quantum mechanics limit the accuracy with which values of pairs of complementary physical quantities can be concurrently predicted. Now, such principles apply not only to *energy* and *time* but also to other pairs of quantities, such as *position* and *momentum*.

Quantum information processing is one of the latest in a long line of remarkable inventions made since the advent of quantum mechanics, the mathematical foundations of which were developed in the 1920s. Before quantum computing, quantum physics already gave rise to many remarkable innovations, such as semiconductor electronics (e.g., transistors), lasers, light-emitting diodes, and magnetic resonance imaging.

Quantum computing exploits quantum phenomena for applications in information processing. The hope is to largely outperform classical computers, at least for certain tasks such as needed in cryptographic applications. Superconducting circuits (the approach pursued by IBM, Google, Intel, and IMEC, amongst others) are relatively easy to manufacture with current technologies and are thus promising candidates to further scale quantum information technologies. Beyond superconducting circuits, however, various technologies are being developed.

Quite expectedly, patents in this field have risen rapidly in recent years. Even patent trolls are now trying to occupy that space and, incidentally, conflict out patent attorneys across the world. So, it is pretty clear that quantum computing is happening in the IP space too.

While quantum-related R&D is an indescribable struggle for scientists, the related innovation can easily be a headache for patent professionals too. Indeed, quantum computing is a very multidisciplinary field, cheerfully blending materials science, electronics, electromagnetism, thermodynamics, and, of course, quantum physics and the corresponding mathematical framework.

On the legal side, things are nevertheless simpler than with other trending technologies (such as, e.g., machine learning), insofar as technological advances in this field are typically not excluded from patentability (unlike, e.g., machine learning algorithms as such). However, there are a few aspects to keep in mind before drafting a patent application. These relate to inventive step (or non-obviousness), clarity, sufficiency of disclosure, scope of the invention, and timing to file a patent application.

Patentability in the sense of patent eligibility is usually not an issue, especially if the gist of the invention concerns very technical/tangible aspects, such as signal transmission or the quantum circuits themselves. However, inventive step (or non-obviousness) may be challenged when the invention shifts toward abstract matters. This may for instance be the case when the residual novelty resides in a particular quantum computing application (e.g., quantum chemistry) or, even, in a particular sequence of qubit operations if such operations do not modify the normal operation of the machine. Other examples of innovations that may be challenged are inventions orbiting in not-so-patentable areas such as software interfaces to classical computers or cloud-based quantum offering. A typical workaround is to tie the novel features with the very technical aspects of the quantum hardware, whenever possible.

Clarity is needed to enable relevant comparisons with the prior art and a sound appreciation of the extent of protection conferred by the patent. Now, quantum processing is still a relatively new field, in which new terminologies swarm. The lack of stable, universally accepted terminologies necessarily impacts the interpretation of the claims and their clarity. Thus, the terms of the claims should, when needed, be carefully defined in the description, if not in the claims themselves.

Another question is whether the disclosed invention is **sufficiently disclosed**. Some inventions are manifestly not reduced to practice, some are only validated by mere simulations performed on conventional computers, while others do not seem to be tested at all. And, sometimes, one wonders whether the claimed invention is at all compatible with actual quantum apparatuses. E.g., some patent claims are not compatible with all the types of qubits covered by the claims. Now, an application that does not sufficiently specify the underlying quantum technology may be found to be insufficiently described.

Correlatively, the **scope** of the invention must be clearly defined. In general, both apparatuses and methods can be claimed. Beyond quantum computers, however, one question that often arises is whether the invention is applicable to other types of quantum apparatuses, such as quantum sensors. The drafter should furthermore ensure that the claims cover all types of qubits that are compatible with the invention, without, however, unduly covering incompatible quantum technology. For example, an invention that was initially meant for Xmon qubits may perhaps apply to other types of superconducting circuits (such as transmons or gatemons), while it may not be applicable to spin-based quantum circuits (spin qubits). Claims that cover more than the compatible technology may be found unclear and/or insufficiently described, as noted above.

Finally, despite the difficulty in predicting the future, it is important to consider the best **timing** to file a patent application. When will the invention really be marketed? Is it really worth filing a patent application now for an invention that may not be monetized for years? That said, like in other fields, experts are often pessimistic as to what will actually be achieved in the near future. So, while applicants should strive not to overlook realities, they can legitimately nourish hopes.

In all cases, drafting a quantum-related application requires a thorough comprehension of the various concepts involved, which the patent drafter cannot afford not to understand.

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