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The Independent-Invention Defense in Intellectual Property

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Abstract: Patents differ from other forms of intellectual property in that independent invention is not a defense to infringement. We argue that the patent rule is inferior. First, the threat of entry by independent invention would induce patentholders to license the technology, lowering the market price. Provided independent invention is as costly as the original cost of R&D, the market price will still be high enough to cover the patentholder's costs. Second, a defense of independent invention would reduce the wasteful duplication of R&D effort that occurs in patent races. In either case, the threat of independent invention creates a mechanism that limits patentholders' profits to levels commensurate with their costs of R&D.

Keywords: patents, trade secrets, licensing, patent breadth

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1 Independent Invention

Perhaps the most basic difference between patents and other intellectual property like trade secrets and copyright is that independent invention is not a defense to infringement. If a firm inadvertently re-invents a patented technology, even an innocent attempt to market its product subjects it to damages and injunctions. This is not true of other forms of intellectual property, in which independent invention is either a recognized defense (*e.g.* trade secrets) or not protected against in the first place (*e.g.* copyright). It is hard to see how the two rules could simultaneously be optimal. In this paper we argue that the best rule is the one found in most areas of intellectual property law, and that the anomalous rule for patent cases is inferior.

At the outset, we note that the anomaly in patent cases may have originated for purely pragmatic reasons. Judges may have feared that fraudulent claims of independent invention would be virtually undetectable in a world where (by definition) patents are part of the public domain and therefore easily copied. Comparable fears would not have existed for other types of intellectual property, where illicit copying can usually be detected by examining the infringing product itself (*e.g.* in copyright) or the trail of wrongful acts needed to breach a competitor's security and obtain the information in the first place (trade secrets).

Whether or not such fears were valid in the past, they are almost certainly outmoded today. For one thing, courts routinely determine issues – *e.g.* which applicant invented a particular product first – that are just as susceptible to fraud as independent invention would be. Perhaps more importantly, the availability of the defense in other areas of intellectual property law has led firms to evolve strategies for reliably demonstrating independent invention. For example, in the software industry, firms commonly sequester their engineers in “clean rooms” before telling them what to develop; the room is then rigorously monitored to make sure that the engineers do not consult legally improper sources of information. The existence of practical methods for demonstrating independent invention means that any remaining questions about whether the defense *should* exist can be addressed as a matter of public policy.

Our objective in this paper is to investigate how a defense of independent invention affects markets and incentives to innovate. We recognize, of course, that independent invention is wasteful, and that patents are published precisely to avoid wasteful duplication. However the possibility of duplication does not mean that duplication will happen in equilibrium. After a patent has issued, the patentholder will avoid duplication through licensing. We argue that a defense of independent invention changes the terms of licensing, which may reduce the market price of a proprietary product without undermining the incentives to innovate.

Our argument is this: To deter entry, a patentholder may license to one or more other firms. By doing so, he commits to a price lower than the monopoly price, and takes away any further threat of entry. Provided that the R&D (duplication) costs of potential entrants are as high as the first patentholder's R&D cost, the licensing agreement will sustain a high enough market price to ensure that the patentholder's R&D costs are covered.

The defense of independent invention has a salutary effect that is otherwise elusive in intellectual property regimes. Namely, it makes the patentholder's rewards reflect the costs of invention. Ordinarily, the market power conferred by a patent is not limited in any way that is related to R&D cost. In the scheme we suggest, the patentholder himself will decide how much competition to allow into the market. He allows entry if and only if the potential entrants' (and his own) R&D costs are relatively low. By inducing entry when R&D costs are low, our scheme brings market prices closer to the marginal cost of producing the good, and reduces deadweight loss without stifling innovation. It is the threat of duplicated R&D costs that accomplishes these objectives, but R&D costs will not actually be duplicated in equilibrium. Independent invention will be frequently threatened and rarely implemented.

The argument is slightly different if the patent is awarded after a patent race. In that case, we interpret the defense of independent invention to mean that all firms who successfully invest in the race can freely use the proprietary technology. Whether or not there is a defense of independent invention, R&D costs will be duplicated in a race. But since the defense of independent invention increases *ex post* competition, there is less incentive to race, and therefore less duplication. The market price will be lower

than the monopoly price. Both consequences - lowering the market price and reducing the wasteful duplication of R&D costs – enhance efficiency without undermining the incentive to develop the new product.

The innovation and licensing markets in this paper operate similarly to those in Gallini (1984) and Gallini and Winter (1985), although those papers focussed on cost-reducing innovations in two-firm markets with no threat of additional entry. Gallini argued that under this scenario the patentholder would license his competitor in order to avoid duplication of the invention. Gallini and Winter then discussed the effects of such licensing on the *ex ante* incentives to invest in cost reductions. However, since the patentee and licensee are not threatened by additional firms, they have an incentive to operate collusively and keep the market price high. In contrast, we assume that there is a threat of duplication from firms other than the licensee(s). In our model, the role of licensing is that it allows the patentholder to commit to a lower market price, which deters entry by as yet unidentified entrants. Our main contribution is to show how the defense of independent invention leads to lower market prices and less duplication of effort, without jeopardizing the overall incentive to develop new products. Remarkably, it gives the patentholder an incentive to limit his own profit in exactly those circumstances where profit can be limited without undermining the incentive to innovate.

In the next section we illuminate the patentholder’s incentive to commit to lower prices through licensing, in order to avoid duplication. In Section 3, we show how the threat of duplication affects patent races. In Section 4 we point out that defining a suitable patent breadth can lead to similar social benefits even when independent invention is not a defense. In Section 5 we discuss the limitations of our arguments, and the dangers inherent in making independent invention a defense.

2 A Model with No Patent Race

First we assume that a single patent has issued, and show how the defense of independent invention can motivate licensing in order to deter entry. Licensing reduces the

market price and benefits consumers without jeopardizing the patentholder's ability to recover R&D costs. In the next section, we introduce a patent race in the same model.

The market game after issuance of the patent is as follows. A patentholder has a proprietary product that can be independently duplicated at the cost of R&D, K . If the patentholder licenses the technology, he will license with a fixed fee and royalty, (F, ρ) , to the maximum number of firms, n , that would find it profitable to enter on those terms. The market price of the patented commodity will depend on the number of licensees and their marginal costs of production, where "marginal cost" includes any royalties they must pay. Since all firms who enter the market, whether by license or duplication, will have the same technology, their "marginal costs" of production will be either c (for the patentholder and possibly an entrant who duplicates the technology) or $c + \rho$ (for a licensee). There will be n market participants with "marginal cost" $c + \rho$ and k participants with marginal cost c . With no entrants, $k = 1$ (the patentholder), and with entry, $k = 2$ (the patentholder plus entrant). In equilibrium, $k = 1$, since the licensing strategy will deter entry. Our objective is to characterize the licensing strategy, n and (F, ρ) , that deters entry, and to show that if demand is "large" relative to R&D costs, the patentholder will undermine his own profit by licensing to several firms at a reasonable royalty rate, after which he earns less than the monopoly profit.

We let $\Pi^P(n, \rho)$ represent the sum of licensees' and patentholder's profit. We assume that all the profit $\Pi^P(n, \rho)$ is collected by the patentholder through the fixed fee F , and the licensees make zero profit. It is optimal for the licensees to accept such terms because, in equilibrium, the royalty rate will be chosen so that entry is deterred. Assuming that there are an unlimited number of potential licensees and entrants, a licensee cannot make positive profit by refusing the license and duplicating the invention. Another licensee would take his place, and then he would not find it profitable to duplicate the invention and enter without a license. Thus the licensee cannot do better than to accept the licensing terms that give him zero profit.

Because of the threat of entry, the patentholder will not charge the monopoly price. Instead he will use licensing to commit to a lower market price in order to deter entry. Of course licensing is only optimal if the costs of R&D (and costs of duplication) are

relatively low; otherwise entry is not a threat, and, indeed, the patentholder might need the whole monopoly profit to cover his R&D costs. But when the R&D costs (and costs of duplication) are low, the threat of entry can improve consumer welfare without reducing incentives to innovate.

We now make the described model more specific by assuming a linear demand curve and Cournot competition. Suppose the inverse demand function is given by the function $q \mapsto a - q$, $a > 0$, and the marginal cost of production is c , $c < a$. In Cournot equilibrium, $q^L(n, \rho, k)$ and $q^C(n, \rho, k)$ are respectively the quantities supplied by each licensed firm and each unlicensed firm. They solve:

$$\begin{aligned} q^L(n, \rho, k) &= \arg \max_q [a - ((n-1)q^L(n, \rho, k) + q + kq^C(n, \rho, k))] q - (c + \rho) q \\ q^C(n, \rho, k) &= \arg \max_q [(a - (nq^L(n, \rho, k) + (k-1)q^C(n, \rho, k) + q))] q - c q \end{aligned}$$

The solutions are

$$q^C(n, \rho, k) = \frac{a - c}{n + k + 1} + \frac{n\rho}{n + k + 1}$$

$$q^L(n, \rho, k) = \frac{a - c}{n + k + 1} - \frac{(k + 1)\rho}{n + k + 1}$$

$$p(n, \rho, k) = a - n q^L(n, \rho, k) - k q^C(n, \rho, k) = a - \left[\frac{n + 1}{n + k + 1} (a - c) - \frac{n}{n + k + 1} \rho \right]$$

$$\begin{aligned} \Pi^P(n, \rho) &= [p(n, \rho, 1) - c] [n q^L(n, \rho, 1) + q^C(n, \rho, 1)] \\ &= \frac{1}{(n + 2)^2} [a - c + n\rho] [(n + 1)(a - c) - n\rho] \end{aligned} \tag{1}$$

We now consider the profitability of entry. Let $\Pi^E(n, \rho)$ designate the profit of an entrant into a market with n licensees paying royalty ρ . The value of $\Pi^E(n, \rho)$ below

reflects the assumption that subsequent to entry the firms achieve a Cournot equilibrium with one additional unlicensed firm.

$$\Pi^E(n, \rho) = [p(n, \rho, 2) - c] q^C(n, \rho, 2) = \frac{1}{(n+3)^2} (a - c + n\rho)^2 \quad (2)$$

Lemma 1 *If the patentholder licenses his technology, the optimal royalty rate satisfies $\rho < \frac{a-c}{3}$.*

Proof: We consider two cases, $K > \frac{1}{9} (a - c)^2$ and $K \leq \frac{1}{9} (a - c)^2$. In the first case, where R&D costs (duplication costs) are relatively high, the patentholder will not license. If an entrant competes with the patentholder in the absence of licensees, each firm earns the duopoly profit $(a - c - 2q^C(0, 0, 2))q^C(0, 0, 2) = \frac{1}{9} (a - c)^2$. No licensees are needed in order to deter entry. Consider the second case. The expression for $q^L(n, \rho, k)$ shows that licensees will not produce in equilibrium unless the royalty rate satisfies $\rho < (a - c)/(k + 1)$. To help deter entry, the licensees must be willing to supply a positive amount after entry, when $k = 2$. Otherwise the patentholder and entrant would again earn duopoly profits $\frac{1}{9} (a - c)^2$, which would not deter entry. The result follows. \square

Proposition 2 *Suppose that the cost of R&D or duplication, K , is smaller than duopoly profit ($K \leq \frac{1}{9} (a - c)^2$). Under the rule that independent invention is a defense to infringement, the market price of the product will be lower than when independent invention is not a defense. The patentholder will earn enough profit to cover his costs.*

Proof: The conclusion follows by inspecting Figure 1, which is drawn for $a - c = 8$. The properties of Π^P and Π^E shown there can be derived mathematically, but Figure 1 is a computer plot using *Mathematica*. The profit $\Pi^P(n, \rho)$ has the same value for all n at $\rho = (a - c)/2$, and the profit $\Pi^E(n, \rho)$ has the same value for all n at $\rho = (a - c)/3$.

The lighter lines in Figure 1 show the entrant's anticipated profit when $n = 1, 2, 3$, as it depends on the royalty rate in the relevant range. The entrant's profit if only the

patentholder is in the market, namely, $\Pi^E(0, 0) = \frac{1}{9}(a - c)^2$, is not shown. Given the number of licensees, n , the entrant's profit rises with the royalty rate, because a higher royalty rate makes the licensees less competitive. Given the royalty rate ρ , Figure 1 also shows that in the relevant range, the entrant's profit falls with the number of licensees. The darker lines in Figure 1 show the patentholder's equilibrium profit (profit with no entry, when the licensees make zero profit) for $n = 1, 2, 3$, as it depends on the royalty rate in the relevant range. The monopoly profit $\Pi^P(0, 0) = \frac{1}{4}(a - c)^2$ is not shown.

Supposing that K is the indicated value (in particular, $\Pi^E(3, \rho) < \Pi^E(2, \rho) < K \leq \Pi^E(1, \rho)$ for some ρ), one can see that entry can be deterred with either two licensees and a relatively low royalty rate, or with three licensees and a higher royalty rate. Entry cannot be deterred with no licensees or with only one licensee, since the entrant's profit $\Pi^E(1, \rho)$ lies above K for all royalty rates ρ when there is only one licensee or none. \square

3 Patent Races

We now ask how the independent-invention rule affects a patent race. The firms in a patent race are independent inventors (none learned the technology from another firm), so that under the independent-invention rule, each successful firm can enter the market at the end of the race. The firms then become market competitors, just as if they had been racing for a trade secret rather than a patent.³

Our conclusion below is that the threat of *ex post* competition will deter some firms from entering the race. The *ex post* competition reduces the market price, and the *ex ante* reluctance to race reduces the duplication of R&D costs. Both effects improve social welfare.

We will use the notation $\Pi^o(k)$ for per-firm profit in an oligopoly with k firms. The

³It does not matter whether all the firms in the race receive patents, or whether the first inventor receives the patent, and the other independent inventors only receive a defense against infringement. In both cases, enough firms will race so that there is no temptation to duplicate after the patent issues.

total profit available to k firms competing in the market is $k\Pi^o(k)$. Our argument depends only on the fact that, with constant marginal costs of production, $k\Pi^o(k)$ is less than the monopoly profit $\Pi^o(1)$ (else the monopolist would choose the oligopolists' price). Although nothing in the argument depends on the specifics of the above model, the value of $\Pi^o(k)$ in the above model is

$$\Pi^o(k) = [a - kq^C(0, 0, k) - c] q^C(0, 0, k) = \frac{1}{(k+1)^2}(a-c)^2$$

We assume that several firms can simultaneously invest the R&D cost K in pursuit of the patent. Under the current rule, where independent invention is not a defense, one patent will issue, and only one firm will be authorized to sell in the market. If there are k firms in a race, each wins the patent with probability $\frac{1}{k}$, so the expected value of entering the race is $\frac{1}{k}\Pi^o(1) - K$. The total amount invested in the race is kK , of which $(k-1)K$ is unnecessary cost duplication. The following proposition says that the independent-invention rule can reduce the cost duplication.

Proposition 3 *Assume that marginal costs of production are constant, so that total profit of firms in an oligopoly with $k > 1$ firms is less than in a monopoly, i.e., $k\Pi^o(k) < \Pi^o(1)$. Under the rule that independent invention is a defense to infringement, there is less (no greater) duplication of costs in a patent race than with the alternative rule, where only one firm can enter the market ex post, and is immune from duplication.*

Proof: If independent invention is not a defense, then the number of firms \bar{k} in the race solves $\Pi^o(1)/\bar{k} \geq K > \Pi^o(1)/(\bar{k}+1)$. This means that each firm in the race makes nonnegative expected profit, and the firms would make negative expected profit if another entered the race. If independent invention is a defense, then the number of firms \tilde{k} in the race solves $\Pi^o(\tilde{k}) \geq K > \Pi^o(\tilde{k}+1)$. Thus, $\Pi^o(1)/(\bar{k}+1) < K \leq \Pi^o(\tilde{k})$, so $\Pi^o(1) < (\bar{k}+1)\Pi^o(\tilde{k})$. But then $\tilde{k}\Pi^o(\tilde{k}) < \Pi^o(1) < (\bar{k}+1)\Pi^o(\tilde{k})$, so $\tilde{k} < \bar{k}+1$, or $\tilde{k} \leq \bar{k}$. \square

Even though the defense of independent invention can reduce the duplication of R&D costs in a race, the wasteful duplication might not be eliminated entirely. There

will be enough firms competing in the market *ex post* so that no licensing is required to deter further duplication. This is because an *ex post* entrant would earn $\Pi^o(\tilde{k}+1)-K < 0$.

Nevertheless, the patent race itself remains wasteful. If there were a fixed number of potential entrants to the race, the identified potential entrants could form a joint venture to eliminate the duplication, sharing the *ex post* profit. However the assumption of unlimited potential entrants makes this impossible, since there will always be another potential entrant ready to race against the joint venture.

4 Patent Breadth as a Policy Instrument

Even though there is currently no defense of independent invention, firms can still “duplicate” inventions by inventing around existing patents. For a suitably chosen patent breadth, the would-be competitor will face the same prospective costs as the original inventor, and the social benefits described above will be recovered. In this interpretation, our arguments shed light on optimal patent breadth, assuming that independent invention is not a defense.⁴

Gilbert and Shapiro (1990) interpret patent breadth as a constraint on how high a monopolist can raise price (holding the market demand fixed), without recognizing that the breadth also affects the cost of duplication. Gallini (1992) assumes just the opposite: She interprets patent breadth as the cost of duplicating the patent, without recognizing that the breadth can affect the market price. Gilbert and Shapiro conclude that a long, narrow patent has lower deadweight loss than a short, broad patent that generates the same revenue. Their argument is that the narrow patent reduces per-period deadweight loss enough to compensate for the longer patent life. Gallini reaches the opposite conclusion, namely, that a short, broad patent is superior. Her argument is that, because the per-period deadweight loss of the monopolist does

⁴Patent breadth governs other economic functions as well. See, e.g., Klemperer (1990) (breadth used to define distance between protected and imitation products in quality space); Green and Scotchmer (1995) and O’Donoghue, Scotchmer and Thisse (1998) (breadth determines whether a new product infringes an old patent in the context of cumulative innovation).

not depend on breadth, the social objective should be to minimize the patent life, subject to preventing duplication. Duplication is prevented by the broad patent.⁵

These contrasting views can be reconciled by the licensing arguments above. We follow Gallini in interpreting patent breadth as the cost of inventing around the patent, but diverge from her assumption that breadth does not affect the market price. Instead we assume that if the patent lasts long enough so that duplication is tempting, the patentholder will avoid duplication by licensing the patent and committing to a lower market price, as described in Section 2. (Gallini assumed that duplication would in fact occur.)

Our licensing story legitimates the assumption of Gilbert and Shapiro that a narrow patent leads to a lower market price. Gilbert and Shapiro interpreted the lower price as a regulatory or antitrust outcome, whereas we interpret the lower price as the endogenous outcome of the patentholder's incentive to avoid duplication. The patentholder with an infinite patent life will himself decide how much to lower the price through licensing, rather than depending on a regulator or patent authority. The price will be tailored by the patentholder to reflect the costs of duplication, and if the costs of duplication are commensurate with his own costs of invention, he will license in such a way that his market profit is commensurate with his R&D costs.

Of course the limitations of the Gilbert and Shapiro treatment remain. Whether long, narrow patents are superior to short, broad patents depends on market considerations such as the shape of the demand curve. Further, Gilbert and Shapiro implicitly impose a regulatory burden to regulate the monopolist's price according to his R&D costs. Similarly, the interpretation here imposes a burden to tailor patent breadth to R&D costs. These burdens would be largely avoided by forcing a lower price through the independent-invention defense.

⁵Hopenhayn and Mitchell (1998) introduce a new slant on the breadth/length tradeoff by arguing that a menu of options should be offered, and firms should be allowed to self-select.

5 Robustness

Our argument in favor of independent invention as a defense to infringement considers two cases. First, if only one firm invests in the patent, the threat of duplication after the patent issues will force licensing. Licensing will reduce market price in a way that benefits consumers without threatening the incentives to innovate. Since duplication will not actually take place, the threat improves efficiency. Second, if several firms race for the patent, the independent-invention rule reduces entry into the race, and thus reduces wasteful duplication. The *ex post* competition among the patentholder and other independent inventors keeps the consumer price lower than under the alternative rule, where independent invention is not a defense. Both consequences improve efficiency.

These are strong conclusions. However it would be incautious to recommend a revision of patent law without investigating their robustness. We conclude by exposing some of the limitations and dangers of our argument.

Our argument will not work if the cost of duplication is much lower than the patentholder's R&D cost. With low costs of duplication, a very low market price is required to deter entry, and the patentholder does not recover his R&D costs. This is why we require that the entrant "duplicate" the invention rather than "copy" it. The costs of duplication should be more or less commensurate with the original costs of R&D, whereas copying is cheap.

The assumption that duplication costs must be as high as the original R&D costs can be somewhat relaxed, and therefore the theory can tolerate some imprecision in the interpretation of independence. In equilibrium, the patentholder makes more profit than a duplicating firm could make (see Figure 1), and the patentholder can therefore recover costs while still deterring entry even if the duplicating firm has some cost advantage.

We turn briefly to some possible criticisms of our argument.

Is independent invention possible? To make the threat of independent invention credible to the patentholder, it presumably has to be accomplished through a clean room. Clean rooms were born as a litigation tactic and have been viewed skeptically. Nevertheless, it is worth asking what they can do in principle.

Under a clean room system, potentially infringing patents would be withheld from the invention team while the firm tried to negotiate licenses. If the firm decided that invention was urgent, it could describe the performance characteristics of whatever product it wanted its team to invent. As long as the request was in writing, a jury could decide whether the firm had short-circuited 'independence' by passing along hints and clues.

Probably the most fundamental objection to independent invention in a clean room is that success in building a product can sometimes provide valuable information all by itself. The atomic bomb is a particularly notorious example. In the great majority of cases, however, the fact that a particular invention is physically possible is never in doubt. Instead, the real question is whether developers can avoid blind alleys in order to arrive at a suitable answer 'on time and under budget.' Knowing that the original inventor has managed to evade such pitfalls says little or nothing about the second inventor's chances of accomplishing the feat a second time.

Most other objections involve either conscious or unconscious cheating. Conscious cheating would occur when employees use surreptitious communications to evade clean room restrictions. Unconscious cheating would occur when an invention became so well known that employees could not avoid it in their daily lives.

The risk of cheating is present in all legislation; the real question is whether the risk is manageable. If clean rooms were the norm, firms would have strong incentives to implement 'zero tolerance' precautions against both conscious and unconscious cheating. This is because they would know that even the tiniest irregularities could persuade a jury to deprive them of their investment.

Is trade secrecy socially efficient? Our scheme works best when lack of access to the patent can be documented. One way to do this would be to seal the patent

until expiration. This comes close to transforming patents into trade secrets. One interpretation of our arguments is that trade secrecy is more socially efficient than patents.

Do our arguments depend on the form of competition in the market? The arguments above assume that firms are Cournot competitors, rather than, for example, Bertrand competitors. Bertrand competition reduces price to marginal cost and profits to zero. These seem like extreme conclusions, but it is worth pointing out that the defense of independent invention improves efficiency even in the Bertrand model. In the first case we considered, where only one firm would invest in the patent, the rule has no effect. *Ex post* duplication is deterred with or without a defense of independent invention, because an entrant could not cover his duplication costs. Bertrand competition in the market would reduce both competitors' profits to zero.

However, at the level of the race, Bertrand competition reinforces our argument that the defense of independent invention is a superior rule. With a defense of independent invention, only one firm would race for the patent, and wasteful duplication in the race would be avoided entirely. If more than one firm raced, the firms would earn zero profit in the product market, and could not cover their R&D costs. This is not true under the alternative rule, where several firms may race for the patent, but only one patent will issue.

What about the fact that invention takes time? One of the deterrents to duplication is that duplication takes time as well as money. Our arguments are easily generalized to include delay. Duplication with delay is less threatening to the patentholder than duplication without delay. If a patentholder licenses competitors immediately, he can deter entrants from embarking on even a delayed process of duplication.

A reason for caution. We have uncovered at least one reason to be cautious in advocating that independent invention should be a defense to infringement, and it relates to an old ambiguity about the efficiency or inefficiency of patent races. Following, for example, Wright (1983), we have taken the view that patent races permit an inefficient duplication of costs, and should be avoided. However other authors (for example, Loury (1979)) take the view that patent races can be efficient because, al-

though they increase R&D costs, they also accelerate innovation, which has offsetting benefits. The model here cannot address that view because the costs of R&D are lump sum, and the timing of innovation is not at issue. If greater rewards lead to faster invention, the existence of an independent-invention defense could inefficiently retard innovation by lowering the patentholder's profit.

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