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Allen J. Roth

SONIC BOOM: A DEFINITION AND SOME LEGAL IMPLICATIONS

By Allen J. Roth

Major, United States Air Force Reserve

IN this rapidly growing jet and missile age the problem of "sonic boom" is becoming more and more apparent. Insurers of property are asking whether damage resulting from sonic boom is covered under the various insurance forms currently in use, such as, coverage under "aircraft" peril, coverage under "explosion" peril, and so on. Claimants' as well as defendants' attorneys are anxiously awaiting court decisions for legal determination of this mysterious newcomer to the liability family.

To date it appears that there are no court decisions deciding even the basic character of a sonic boom. For this reason the author has submitted what he believes to be a workable definition of sonic boom for consideration by the courts deciding sonic boom matters.[1]

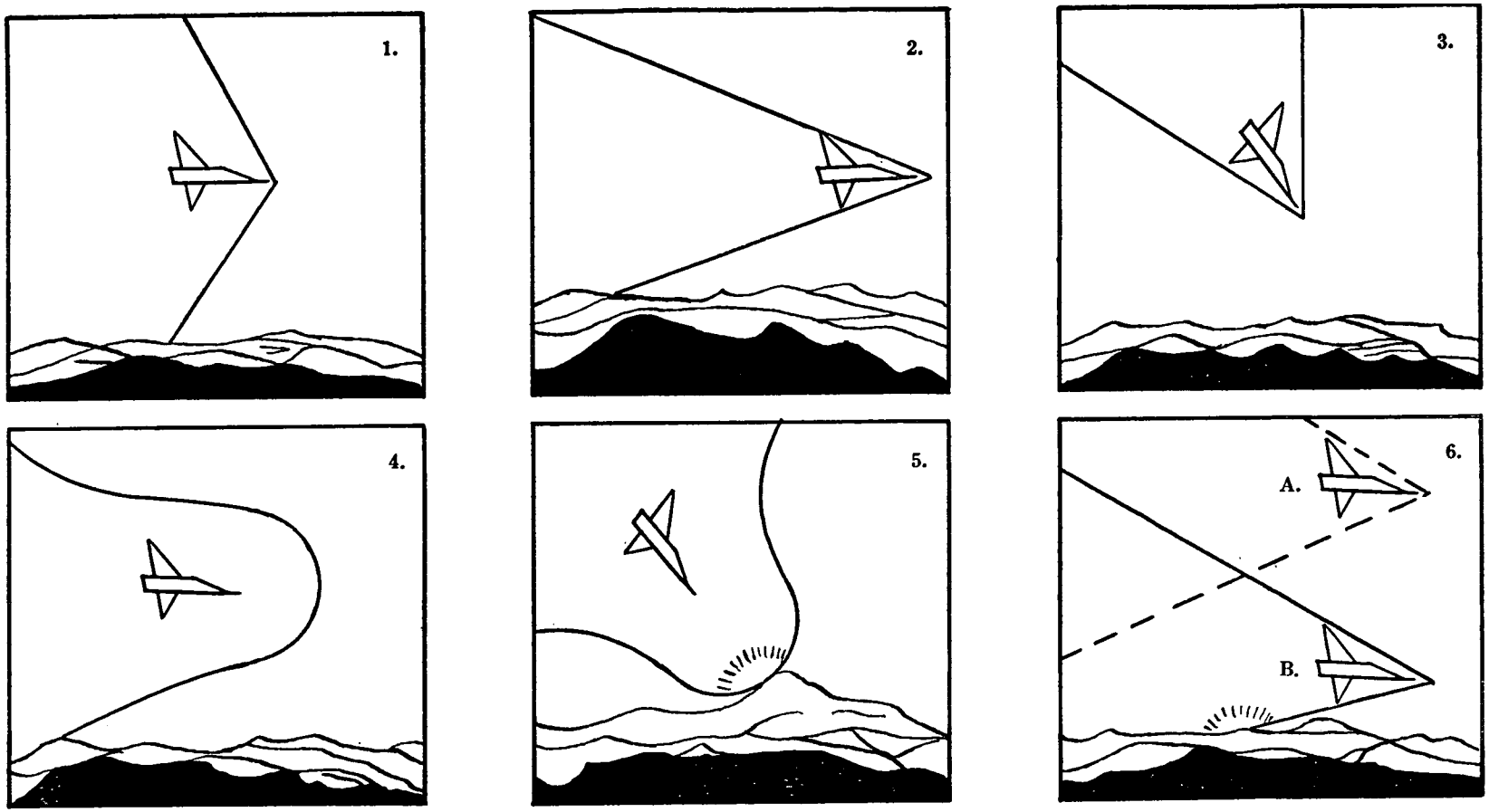
Before the insurer's or attorney's questions can be answered with respect to damages alleged to have been caused by sonic boom, it is imperative that the phenomenon be understood in order to dispel some of the factual mist so that the legal problems can be seen more clearly. To that end the writer directs this article.

Perhaps the first publicized occurrence of alleged sonic boom damage appeared in a nationally-known magazine wherein it was reported that a Marine Corps pilot, while in the process of capturing the transcontinental speed record, created a sonic boom over Terre Haute. In the home of Mr. and Mrs. Louis Howerton of that city the ceiling collapsed, they claim, as a result of the sonic shock wave directed at the ground by the descending jet.[2]

Obviously, in processing a claim of this sort it is first necessary to understand the basic character of the phenomenon before proceeding further.

Early in 1950, an Air Force radar operator using a new technique to gather test data by following the steep dive of a jet fighter through electronic tracings on his observation scope was startled by a deep-throated clap like thunder. Twice more that day and the next the deep booms rumbled unexpectedly as the operator followed similar dives. In wondering disbelief, he asked that the dives be repeated four times in quick succession. Distinct explosive sounds were heard each time. The somewhat happenstance discovery of the radar operator was the first recorded observation of the sonic boom, a widely publicized and

[1] Roth, *Sonic Boom: A New Legal Problem*, 44 A.B.A.J.—(1958).
[2] Life, July 29, 1957, pp. 15-21.



Cross-Sectional Views of Shock Waves Created by Supersonic Aircraft

1. After transonic penetration, the shock wave is created and takes on the form of a shallow dish perpendicular to the line of flight. 2. As the speed of the aircraft increases, the form of the shock wave develops into a somewhat more conical shape. 3. In a supersonic dive the shock wave is pointed earthward. 4. After the aircraft slows down and returns through the transonic area and is once again flying at subsonic speed, the shock wave detaches itself from the the aircraft, follows the direction to which it was pointed at the moment of detachment and gradually smooths into a ball shape. This ball-shaped form of energy continues travelling under its own momentum until it finally dissipates.

5. If the aircraft was pointed earthward at the time the shock wave was detached, the resulting ball-shaped form of energy eventually strikes the ground and is interpreted by the human ear as a "sonic boom." 6. An "attached" shock wave may also be capable of producing a sonic boom when the trailing edge of the cone-shaped wave reaches the ground during supersonic speeds in level flight (as in airplane B, above). If the distance between airplane and ground is too great, the wave may not be of sonic boom proportions where it touches the ground (as in airplane A, above).

often misunderstood phenomenon of sound caused by an airplane traveling at supersonic speeds.[8]

To better understand the make-up of a sonic boom, it is first necessary to consider the object that generates the shock waves which cause the boom. Any mass traveling at a speed greater than sound, through air, will set up shock waves. The supersonic jet aircraft is one example. When the jet has a velocity equal to the velocity of sound, it is said to have a "Mach number" equal to unity (Mach 1). At this point, under standard atmospheric conditions—a temperature of 15 degrees Centigrade and a barometric pressure of 29.92 inches of mercury—at sea level elevation, the speed of sound is approximately 760 miles per hour. Thus it can be seen that temperature and barometric pressure are capable of affecting the point at which the speed of sound is reached under a particular set of circumstances.

Since the barometric pressure roughly halves itself with every 18,000 feet increase in altitude, and the temperature also decreases significantly at the greater heights, it follows that the higher an aircraft flies the sooner Mach 1 is reached, so that at 40,000 feet the speed of sound is about 660 miles per hour as compared to 760 miles per hour at sea level. Mach 2 is merely two times the speed of Mach 1. Mach 3, three times that of Mach 1, and so on.

Aerodynamicists classify speed ranges into four areas: subsonic, transonic, supersonic, and hypersonic. Subsonic is any speed less than Mach 1. Transonic is approximately Mach 1. Supersonic is more than Mach 1 but not over Mach 4.5, with hypersonic speeds exceeding the latter figure.

When a jet aircraft penetrates the transonic and enters the supersonic area, shock waves of intense pressure are created that attach themselves to the aircraft during supersonic flight. For all practical purposes, the shock wave attached to the nose of the plane, being the strongest, will be of prime concern, although it should be noted that other shock waves of less intensity also spring from the wing, canopy, and tail of the aircraft. So long as the aircraft flies at supersonic speeds the shock waves remain attached to it.

The shock wave, upon its creation, takes on the form of a shallow dish perpendicular to the line of flight with the nose of the aicraft at the midpoint of the imaginary dish. As the speed of the aircraft increases, the form of the shock wave develops into a somewhat more conical shape. After the aircraft slows down and returns through the transonic area and is once again flying at subsonic speed, the shock wave detaches itself from the aircraft, follows the direction to which it was pointed at the moment of detachment and gradually smooths into a ball shape. This ball-shaped form of energy continues traveling under its own momentum until it finally dissipates.

If, on the other hand, the object that has created the shock wave was pointed earthward at the time the shock wave was detached, the

[8] Rice, *Sonic Boom*, an undated pamphlet of North American Aviation, Inc.

resulting ball-shaped form of energy eventually strikes the ground and is interpreted by the human ear as a sonic boom.

By its nature a shock wave is strongest at its point of origin, which in the case of a supersonic jet aircraft is at the nose of the aircraft. The shock wave becomes progressively weaker as it bends backward and extends outward from the aircraft. Even after the shock wave is detached by the plane's slower speed, the strength of the shock wave will remain centered as it bends into a ball shape. It is also important to note that an attached shock wave may be capable of producing a sonic boom even though it is still attached to the aircraft. This would occur when the trailing edge of the cone-shaped wave reaches the ground during supersonic speeds in level flight. As the trailing edge of the shock wave is dragged along the ground each person standing along the line of the path of the supersonic aircraft will hear a boom if the shock wave has not been weakened by the distance it extends from the aircraft. Naturally, if the distance is too great the wave may not be of sonic boom proportions where it touches the ground.

Thus far we have seen that there is a distinction between a shock wave and a sonic boom. Very often in the normal course of discussion of the subject matter this important dichotomy is either overlooked or completely misunderstood. A shock wave, either freed or attached, is merely a "potential" sonic boom which will eventually dissipate. It is only when some one, or some thing, in its path is disturbed by this form of energy that a complete sonic boom has been produced.

Under the laws of physics a sonic boom has at least two undisputed characteristics of explosion, namely, a sudden application of energy and an accompanying noise or vibrational disturbance. Clearly, if a human or animal ear is located in the path of a sonic boom it is interpreted as a loud noise. If no hearing mechanism is within range of the sonic boom it is more accurately described as a vibrational disturbance. In either event a sudden application of energy exists.

The question arises—Is sonic boom an explosion? Webster defines "explode" as "To burst or expand violently and noisily as an effect of a sudden production or release of pressure; as gunpowder *explodes;* the boiler *exploded.*" He defines "explosion" as "a violent bursting or expansion, with noise, following the sudden production of great pressure, as in the case of explosives, or a sudden release of pressure, as in the disruption of a steam boiler."

If full effect is to be given Webster's definition it becomes doubtful whether a sonic boom would qualify as an explosion. Webster says ". . . the sudden production of great pressure. . . ." Obviously, there is nothing sudden about a shock wave produced by a jet aircraft, let us say, over Denver and subsequently dispatched over Kansas City, at least not in the sense ". . . as in the case of explosives. . . ." Explosives, as Webster uses the term here, are substances capable of developing a sudden pressure on their surroundings, this development of pressure being caused by the rapid conversion of the explosive substance into

gases having a much greater volume than the original explosive. The substances referred to may consist of gases, liquids or solids; for example, the explosive mixture of gas or petrol vapor with the air in the internal-combustion engine (gas); nitroglycerin (liquid); gunpowder (solid).

The other part of Webster's definition wherein he says ". . . a sudden release of pressure, as in the disruption of a steam boiler, . . ." is equally wanting as a definition embracing sonic boom. Here we find that our hypothetical shock wave, with all its attendant characteristics —energy, noise, etc.—which was created by the jet in Denver, was in being at that time and remained so until dispatched over Kansas City. Hence, it is more accurate to say that the boom was a "sudden *application* of energy" rather than to refer to it as a "sudden release of pressure" as in the case of an exploding steam boiler. In other words, our hypothetical supersonic jet *created* the shock front over Denver, *directed* it cross-country, and *dispatched* it over Kansas City. Therefore, if these distinctions are validly drawn, a judge or jury may properly find that sonic boom is a sudden "application" of energy and not a sudden "release" of pressure.

Under many extended coverage endorsements to policies insuring commercial and residential property loss by explosion is covered. But, the endorsements rarely contain a decisive definition of the term "explosion," and it is doubtful whether any of the explosion exclusions are applicable to sonic boom damage unless clearly and specifically drafted to so provide. Therefore, it must be determined whether or not the phenomenon known as "sonic boom" is an explosion before coverage can be determined under those insuring agreements.

The writer's personal observation has disclosed that due to a decided lack of information on just what is a sonic boom, insurers tend to conclude that it is not an explosion and are adhering to that position pending further information on the subject. Indeed, this is brought about mainly by the fact that no cases have been decided to date. What the future holds in store is anyone's guess, yet, a reasonable prediction may be obtained by reviewing some case laws on the subject of explosion.

The United States Supreme Court in *Mitchell* v. *Potomac Insurance Company,* decided in 1901, found no error in the trial court's instruction to the jury over the meaning of the word "explosion" as used in an insurance policy:

> "Now, gentlemen of the jury, when the word 'explosion' was used in the policy, the company as ordinary men—at least its officers were ordinary men and not, as I assume, scientific men—and the party insured an ordinary man, are presumed to have understood the word 'explosion' in its ordinary and popular sense. Not what some scientific man would define to be an explosion, but what the ordinary man would understand to be meant by that word. And, after all, the question here being explosion or non-explosion, is, what do you, as ordinary men, understand occurred at that time

> in the light of all the testimony? Was it an explosion in the ordinary and popular sense of that word, . . . ?"[4]

The Court in this case made clear that the word "explosion" when used in an insurance policy is that which ordinary men, not scientists, understand an explosion to be, and that the parties to a policy are presumed to have understood the word "explosion" in its ordinary and popular sense.

A more recent case, *Hyman & Company* v. *American Motorists Insurance Company,* of 1955 vintage, distinguished the *Mitchell* case. The United States District Court of the District of Colorado was not fully in accord with the commonly accepted notion of what constitutes an explosion. The judge in the *Hyman* case spoke as follows:

> ". . . My decision must rest upon the facts, viewed in the light of the principles and reasoning of the cases, and the usual definition of explosion as 'a violent bursting, or expansion, with noise, following the sudden production of great pressure, as in the case of explosions, or a sudden release of pressure as in the disruption of a steam boiler; also the noise made by such bursting.' Webster's New International Dictionary, 2d Ed.
>
> "It must be recognized that there are various degrees of violence and noise, explosions can be of different kinds or degrees. No single element, or the degree or extent of that element, furnishes the final answer. Yet it also must be recognized that every sudden tearing asunder from pressure from within is not an explosion, . . ."[5]

Here we find the court is not at variance with the decision of the *Mitchell* case, yet, quite unwilling to apply the ordinary and popular sense of the term "explosion" to the breaking of a pipe in a boiler, preferring instead to classify it as a "rupture" even though the rupture was caused from within by sudden pressure and with sufficient violence.

An even more recent case, *Heffron* v. *Jersey Insurance Company of New York,* decided in late 1956, again distinguished the *Mitchell* case. The court in the *Heffron* case said "Usually the parties in using words in an insurance contract are deemed to have used the word [explosion] in accordance with the ordinary meaning of the term. But it is otherwise where the language of the policy or the circumstances of the parties indicate a different intention."[6]

From the foregoing it may safely be stated that a court deciding a sonic boom damage case of first instance could apply the ordinary-man rule in regard to whether or not sonic boom is an explosion. There is no assurance however that sonic boom will be classified as an explosion under this rule since ordinary men may not tend to associate an aircraft flying at supersonic speed with the more commonly known explosive materials such as dynamite, gasoline, nitroglycerine, gunpowder, or for that matter, an exploding tank or boiler.

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[4] *Mitchell* v. *Potomac Insurance Company,* 183 U.S. 42, 52 (1901).

[5] *Julius Hyman & Company* v. *American Motorists Insurance Company,* 136 F. Supp. 830, 834 (D. Col. 1955).

[6] *Heffron* v. *Jersey Insurance Company of New York,* 144 F. Supp. 5, 10 (E.D.S.C. 1956).

Ordinary men are aware that these materials in one way or another always change form after the explosion has occurred, and when confronted with the facts of sonic boom, finding that the object which created the boom is still whole and unimpaired after the boom, they might thereby be influenced in favor of separating sonic boom from the ordinary and common experiences of explosion. Hence, since ordinary men could conceivably distinguish these explosive sources, i.e., fail to see a sufficient similarity, it may reasonably be predicted that sonic boom might very well be classified as a phenomenon other than an explosion.

The same also holds true for the court whose decision "must rest upon the facts, viewed in the light of the principles and reasoning of the cases, and the usual definition of explosion."[7] If the court should decide upon rigid application of Webster's definition of explosion it may not be too far-fetched to speculate that very probably sonic boom will emerge as something other than an explosion in the ordinary and popular sense.

The apparent uncertainty of the situation is perhaps best described by the courts themselves. "The term 'explosion' has no fixed and definite meaning either in ordinary speech or in the law."[8] "The word 'explosion' is variously used in ordinary speech, and is not one that admits of exact definition."[9]

A legal representative of a nationally-known insurance company conveyed this interesting attitude to the writer: "As the word [explosion] has been used in conversation every day between peoples, and as it is used in the insurance contracts we write, we do not believe sonic boom to be an explosion. There may be many elements of similarity between the two, but there are points of difference also. We think of the explosion as being over instantaneously, whereas the sonic boom phenomenon continues for whatever length of time the plane is traveling in excess of the speed of sound. Until there have been more developments and more knowledge released concerning the sonic boom phenomenon, we believe our position on [sonic boom] coverage should be as indicated."

The foregoing may very well be representative of the industry. Recently sonic boom damage occurred during the conduct of an air show in Oklahoma City. The damage was extensive, and the Insurance Commissioner called an informal hearing of all companies to explore the coverage available for such damage. The companies almost unanimously reported their views on coverage in accordance with the above conclusions—i.e., sonic boom is not an explosion.

Clearly, then, the "intention" of the insurers referred to above is

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[7] *Supra* note 5.

[8] *Vorse* v. *Jersey Plate Glass Insurance Company*, 119 Iowa 555, 557, 93 N.W. 569, 570 (1903).

[9] *The United Life, Fire and Marine Insurance Company*, v. *John T. Foote et al*, 22 Ohio St. 340, 347, 10 Am. Rep. 735, 740 (1872).

not to include sonic boom when using the word "explosion" in their insurance contracts.

Thus far we have seen that:

(1) sonic boom damage is real,
(2) to date sonic boom cases have not been litigated,
(3) the basic character of sonic boom must be decided before liability for damage resulting therefrom can be determined,
(4) the primary question for determination is whether or not sonic boom is an explosion,
(5) a fair prediction is that sonic boom will be legally defined as something other than an explosion.

Who will eventually decide the question? ". . . [I]t is a question for the jury to determine, in all such cases, whether there has been an explosion, how and by what means produced, and whether the loss sustained was directly caused by the explosion, . . ."[10] Of course, an exception would be if the United States were a defendant in a suit brought under the Federal Tort Claims Act, in which case the suit would be tried by a judge without a jury.[11]

If the prediction contained in (5) above materializes, what will sonic boom be called? It is the contention of this writer that should the courts decide sonic boom is not an explosion they would of necessity have to hold that it is an entirely new phenomenon, and that this phenomenon is clearly limited to air since supersonic flight speed through air is an essential requirement for the creation of supersonic shock waves.

So far, then, we have (a) a phenomenon of the air, (b) produced by supersonic flight, (c) which created shock waves of sonic boom proportions. There is yet one element necessary for a complete definition of sonic boom, namely, it must strike something or someone so as to bring about a "booming" effect. This of course entails a sudden application of energy and an accompanying noise or vibrational disturbance, the two undisputed characteristics of explosion.

Since it has been demonstrated that a sonic boom is a phenomenon of the air, and since it is common knowledge that there are many phenomena of the air, it is necessary to determine what kind of phenomenon sonic boom is. It was also demonstrated that significant characteristics of explosion are present in sonic boom. Therefore, it is correct to label the sonic boom as an *explosive* phenomenon of the air.

Hence, the following definition of sonic boom evolves, and the writer submits this definition for consideration with respect to subsequent litigation of the matter:

SONIC BOOM IS AN EXPLOSIVE PHENOMENON OF THE AIR CAUSED BY SHOCK WAVES GENERATED AT SUPERSONIC FLIGHT SPEEDS.

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[10] *The Transatlantic Fire Inurance Company of Hamburg, Germany* v. *Michael T. Dorsey*, 56 Md. 70, 82, 40 Am. Rep. 403, 408 (1881).
[11] 28 U.S.C. § 2402 (1954).