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The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Doing laundry is an essential household task, but have you ever wondered exactly how much water your washing machine consumes with each load? Whether you're concerned about your utility bills, trying to reduce your environmental footprint, or simply curious about the efficiency of your washing machine, understanding your washing machine's water usage is worth knowing. In this article, we'll explore typical water consumption rates for different types of washing machines, factors that affect water usage, and practical tips to reduce the amount of water your laundry routine requires. With water conservation becoming increasingly important, this knowledge can help you make more informed decisions about your laundry habits. The amount of water a washing machine uses varies significantly depending on several factors, most notably the type of washing machine you own: Traditional top-loading washing machines are the heaviest water users among residential washing machines. These older-style machines typically use between 30 to 45 gallons (113 to 170 liters) of water per load. The large water usage is due to their design, which requires the tub to fill completely to submerge clothes for cleaning. High-efficiency top-loaders represent an improvement in water efficiency. These machines typically use around 15 to 30 gallons (57 to 113 liters) per load. They achieve this reduction by using sensors to determine the appropriate water level for the load size and by utilizing different washing motions that require less water. Front-loading washing machines are generally the most water-efficient option available. These machines typically use between 7 and 20 gallons (26 to 76 liters) of water per load. Their horizontal drum design allows clothes to be lifted and dropped into a small pool of water at the bottom of the drum, rather than needing to be completely submerged. Compact washing machines, often found in apartments or smaller homes, generally use less water simply because they handle smaller loads. These machines typically use around 7 to 15 gallons (26 to 57 liters) per wash cycle. Several factors influence how much water your washing machine will use for each cycle: Newer washing machines are generally designed to be more water-efficient than older models. Machines manufactured after 2018, when stricter efficiency standards were implemented, tend to use significantly less water than those made before this time. Most modern washing machines have sensors that detect the size of the load and adjust water usage accordingly. However, if you manually select the load size or if your machine lacks these sensors, a small load in a large setting will waste water unnecessarily. Different wash cycles use varying amounts of water: Regular/Normal cycles typically use a moderate amount of water Heavy-duty or sanitize cycles often use more water to thoroughly clean heavily soiled items Quick wash cycles might use less water but may not clean as effectively Eco or water-saving cycles are specifically designed to minimize water usage Selecting an extra rinse will add more water to the total used. While this option can be beneficial for removing detergent residue from clothes, particularly for those with sensitive skin, it adds significantly to water consumption. Many washing machines allow you to select how dirty your clothes are. Higher soil level settings typically use more water to better clean heavily soiled items. IMPORTANT: Before attempting to modify your washing machine's water usage, always consider these safety precautions: Never override safety features designed to ensure proper machine operation Using too little water can damage your machine's motor and other components Insufficient water may not fully dissolve detergent, potentially leaving residue on clothes Always follow the manufacturer's recommendations for your specific model If you're looking to minimize your washing machine's environmental impact and reduce your water bills, here are some practical tips: Match the water level to the amount of laundry you're washing. Many machines have automatic load sensing, but if yours doesn't, be conscious about selecting the appropriate setting. Rather than running several small loads, wait until you have enough laundry for a full load. This maximizes efficiency without wasting water on half-empty cycles. Use eco-friendly or water-saving cycles whenever possible. These are designed specifically to minimize water usage while still cleaning effectively. Unless someone in your household has sensitive skin or you're washing heavily soiled items, avoid using the extra rinse option, as it can add several gallons of water to each load. Too much detergent can require more water to rinse out completely. Follow the detergent manufacturer's recommendations for your load size and machine type. If your washing machine is over 10 years old, consider replacing it with a newer, more efficient model. Look for ENERGY STAR® certified machines, which use about 25% less water than non-certified models. Inspect hoses regularly for leaks or cracks, and ensure connections are tight. Even small leaks can waste significant amounts of water over time. While many water-saving measures can be implemented on your own, some situations warrant professional assistance: If you notice your washing machine is using much more water than it should for the selected cycle If you see leaks or water pooling around your machine If your machine's automatic water level sensor seems faulty If you're considering a major modification to your machine's water system Professional technicians can diagnose issues affecting water usage and recommend appropriate solutions without compromising your machine's functionality or safety. To ensure your washing machine continues to operate at peak water efficiency: Clean the machine regularly according to the manufacturer's instructions Run a maintenance cycle monthly to remove buildup that might affect sensors Check and clean filters regularly to prevent clogs that could affect water flow Consider water softeners if you live in a hard water area, as mineral buildup can affect machine efficiency Remember that even small changes to your laundry habits can add up to substantial water savings over time, benefiting both your wallet and the planet. If water conservation is important to you, consider making your laundry routine more water-efficient today. Water is the most precious resource on our planet, and it's essential for human survival. But the fresh, clean water that we need isn't an endless resource. We're now using fresh water supplies faster than ever before, so it makes sense for us all to do our best to try and reduce how much water we consume in our homes. On a personal level, saving water also saves us money. Over 60% of UK homes now have a water meter installed, where customers are billed for the amount of water used. Even if you don't have a water meter, you will still pay local utility charges, and the greater the demand for water, the greater the price. How Much Water Does a Washing Machine Use? In the past, washing machines could use a staggering 150 litres of water per cycle – that's almost as much water as most people now use in an entire day (146 litres according to Statista). The good news is that this has reduced significantly due to advances in technology in the last 20 years. We looked at 54 popular washing machines on the market in the UK, and found that the average washing machine uses 48.8 litres per cycle. See the data below: ModelDrum capacity (kg)Energy ratingLitres per cycleLitres per kg capacity Hotpoint BIWMHG71483UKN7D49.37.0 Indesit My Time EWD71453WUKN7D46.06.6 Beko RecycledTub® WTIK76151F7C44.06.3 Baumatic BWI147D4E7D44.06.3 Bosch Series 4 WAN28081GB 7C41.05.9 Samsung Series 5 ecobubble™ WW70TA046TE7B33.64.8 Hotpoint NSWM743UGGUKN7D45.06.4 Beko WTIK721117C41.05.9 Hotpoint NSWM743UBSUKN7D45.06.4 Smeg WMI147C7E47.06.7 Zanussi ZW74PDBI 7B44.06.3 Indesit My Time EWD81483WUKN8D53.86.7 Hotpoint NSWA845CWWUKN8B48.06.0 Beko WTL84121W 8C45.05.6 Haier HW80-B1439N8A38.24.8 Hisense WFQA8014EVJMT8A32.04.0 Hotpoint BIWMHG81484UK8C54.16.8 Miele WSD023WCS8A47.05.9 Hoover HBWS48D1ACE8C44.85.6 Haier i-Pro Series 5 HW80-B14959TU18A44.05.5 Candy CBW48D1E 8D45.05.6 Samsung Series 5 ecobubble™ WW90TA046AE9A42.74.7 Hotpoint NSWA945CWWUKN9B50.05.6 Haier Series 4 HWQ90B416FWB-UK 9A46.05.1 Samsung Series 5 ecobubble™ WW90TA046AX9A42.74.7 Hoover H-WASH 300 H3W69TMBBE/19B46.05.1 Samsung Series 5+ AddWash™ WW90T554DAN9A42.74.7 Hotpoint BIWMHG91484UK9C56.16.2 Hotpoint NSWM945CGGUKN9B53.15.9 LG V3 FAV309SNE9B50.05.6 Hoover H-WASH 300 PRO HBWOS69TAME9A46.05.1 Beko WTL104121W10B57.05.7 Haier HW100-B1439N10A45.24.5 Hotpoint NM111046WDAUKN10A52.05.2 Hisense WFQA1014EVJMT10A46.04.6 Beko Aquatech® RecycledTub® B5W51041AW10A39.03.9 Zanussi ZWF142F1DG10A53.05.3 Hoover H-WASH 300 H3W4102DE10E58.65.9 Hoover H-WASH 500 HW410AMC/110A55.05.5 Indesit BWE101685XWUKN10B59.15.9 Haier i-Pro Series 3 HW100-B14939S10A50.05.0 Samsung Series 5 SpaceMax WW11BGA046AE11A54.04.9 Hoover H-WASH 500 HW411AMC/111A55.95.1 Hotpoint ActiveCare NLCD1164DAWUKN 11C58.45.3 Samsung Series 6+ AutoDose™ SpaceMax WW11BB534DAB11A54.04.9 Samsung Series 8 WW11BB945DGMS111A54.04.9 Whirlpool FFD11469BSVUK11A54.04.9 LG EZDispense™ F4Y711BBTA111A54.04.9 Hisense WFQA1214EVJM 12A55.04.6 LG TrueSteam™ FH4G1BCS212A50.04.2 LG V7 F4V712STSE12B57.04.8 Haier i-Pro Series 7 HW120-B1497912A48.94.1 Hoover H-WASH 500 HW414AMC/1 14A62.34.4 Hoover H-WASH 500 HW412AMBCB/112A56.44.7 The amount of water used is related to the drum capacity. Washing machines with a small drum capacity of 7 kg, for example, tend to use less water than machines with a big 12 kg capacity. This doesn't mean that large machines are less efficient. In fact, large machines tend to use less water per kg of laundry washed, making them more water-efficient as you can wash more clothes with less water. It's also worth noting that front-loading washing machines almost always use less water than top-loading appliances. All of the washing machines we looked at were front-loading models. 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According to American appliance brand Maytag, the average top-loading washing machine with an agitator uses 19 gallons (72 litres) of water per use, while the average high-efficiency top-loading washing machine uses 13 gallons (49 litres) of water per use. We found that the average front loader uses 48.8 litres of water per use, which is less than both a high-efficiency top loader (49 litres) and a regular top loader (72 litres). What's the Most Water-Efficient Washing Machine in the UK? The most water-efficient washing machine we could find is the Beko Aquatech® RecycledTub® B5W51041AW. It has a drum capacity of 10 kg and uses just 3.9 litres of water per kg of laundry washed, working out at 39 litres in total per cycle. The drum of this washing machine is made using recycled bottles, helping reduce its carbon footprint and make it more environmentally friendly. While we consider the Beko B5W51041AW to be the most water efficient model due to its low water usage per kg of laundry washed, the Hisense WFQA8014EVJMT actually uses less water per cycle—just 32 litres. However, the Hisense WFQA8014EVJMT has a smaller drum capacity (8 kg) than the Beko B5W51041AW (10 kg), so it works out as less water efficient when you consider you can't wash as much laundry at once. It could be a good choice for smaller households who don't need a big 10 kg drum though. Do Energy Ratings Reflect Water Usage? Washing machine energy ratings are based solely on electricity usage, not water usage. Therefore, machines with better energy ratings don't necessarily use less water. However, according to our data, better energy efficiency ratings are correlated with more efficient water usage. This makes sense, as manufacturers who invest in making machines energy efficient are likely to also invest in making them water efficient. 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Synthetic wash cycles tend to use more water to avoid creasing, so it may be worth using cotton wash cycles as much as possible and then grabbing the iron to do some manual crease control afterwards. Finally, avoid using the extra rinse setting unless absolutely necessary. In The Wash is your guide to the best laundry and cleaning products, tips and tricks. Our mission is to solve the UK's cleaning and laundry dilemmas! Water is the most precious resource on our planet, and it's essential for human survival. But the fresh, clean water that we need isn't an endless resource. We're now using fresh water supplies faster than ever before, so it makes sense for us all to do our best to try and reduce how much water we consume in our homes. On a personal level, saving water also saves us money. Over 60% of UK homes now have a water meter installed, where customers are billed for the amount of water used. 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Synthetic wash cycles tend to use more water to avoid creasing, so it may be worth using cotton wash cycles as much as possible and then grabbing the iron to do some manual crease control afterwards. Finally, avoid using the extra rinse setting unless absolutely necessary. In The Wash is your guide to the best laundry and cleaning products, tips and tricks. Our mission is to solve the UK's cleaning and laundry dilemmas! Did you know the average UK home uses about 13,000 litres of water each year for laundry? This shows how much water our washing machines use every day. With concerns about water scarcity growing, it's vital to understand how our appliances use water. This guide looks at how washing machines use water in the UK. It gives you tips to use less water and live more sustainably. We'll show you how to make your washing machine use less water and help the planet. The average UK household consumes 13,000 litres of water per year for laundry, highlighting the substantial water footprint of washing machines. This article explores the water usage patterns of washing machines in the UK, providing insights to help consumers make informed, water-efficient choices. The guide covers the water footprint of laundry cycles, factors influencing water consumption, and strategies for improving water efficiency in the home. Consumers will learn about eco-friendly laundry practices and water-wise appliances to reduce their environmental impact and contribute to sustainable water management. The article offers a comprehensive understanding of washing machine water usage, empowering readers to make informed decisions and adopt water-saving habits. Washing machines are key in our daily routines, but we often ignore how much water they use. It's vital to know their water usage. This affects our bills and the planet. The water used by washing machines changes a lot. It depends on the model, cycle, and how full it is. Smaller ones, like 7 kg, use about 40 litres per wash. But bigger ones can use up to 100 litres or more. It's good to use a water usage calculator UK to see how much your machine uses. Wash cycle: Different cycles, like delicate or heavy-duty, change how much water is used. Load size: Bigger loads need more water for cleaning. Smaller ones use less. Water efficiency: New, efficient machines use less water. Some use as little as how much water does a 7 kg washing machine use. Water pressure: Places with high water pressure use more water per cycle than those with low pressure. Knowing these things helps us pick the right washing machine or change our laundry ways. This way, we can save water and help the planet. The world is becoming more aware of the environment, leading to big changes in washing machine tech. Now, energy-saving cycles and high-efficiency washers help use less water. This makes them key for saving water at home. By using these new features, people can greatly reduce their impact on the planet during laundry. Modern washing machines now have special water-saving programmes. These cycles use less water but still clean clothes well. This means people can do laundry efficiently and save a lot of water. High-efficiency washers are also becoming more common. They use less water for each load thanks to advanced technology. These machines are great for those who care about the environment. By choosing these machines, people help make living sustainably easier. FeatureBenefitEnergy-saving cyclesReduces water consumption without compromising cleaning performanceHigh-efficiency washersDramatically lower water usage compared to traditional modelsWater-wise appliancesEnable households to adopt a more sustainable laundry routine More people want to protect the environment, so demand for water-efficient washing machines is rising. By buying these modern machines, people help save water and enjoy a greener laundry routine. In today's world, it's vital to use eco-friendly laundry methods. These practices help save water and cut down on energy use. By doing so, homes can lessen their impact on the environment. When buying a new washing machine, look for one that uses less water. Front-loading or top-loading machines that are high-efficiency use less water than older models. Choosing these can greatly reduce water use and help the planet. Run full loads: Aim to wash larger, full loads of laundry rather than smaller, more frequent cycles to maximise water efficiency. Use the right water level: Adjust the water level setting on your washing machine to match the size of your load, avoiding excessive water usage. Opt for cold water: Washing in cold water can save a substantial amount of energy and water compared to hot water cycles. Implement a greywater system: Consider installing a greywater system to recycle and reuse water from washing machines for other household purposes, such as irrigation. FeatureBenefitEnergy-efficient AppliancesReduced energy consumption and lower utility billsWater-saving Washing MachinesSignificant reduction in water usage per loadEco-friendly DetergentsMinimised environmental impact and improved water quality By using eco-friendly laundry methods, homes can help create a better future. Choosing appliances that save water and using smart water-saving tips are great ways to make a difference. These actions make laundry more sustainable and convenient. Knowing how much water your washing machine uses is key to making smart choices. We'll explore how washer capacity affects water use. This will help you figure out your machine's water usage and manage it better. The size of a washing machine, in kilograms (kg), affects how much water it uses. Generally, bigger machines use more water per cycle. But, the exact amount can change based on the model and its efficiency. To estimate your washing machine's water use, follow these steps: Find out your machine's capacity in kilograms (kg). Then, multiply the capacity by the average water use per kilogram, usually between 8 to 15 litres. This will tell you the water used per wash cycle. For instance, a machine with an 8 kg capacity and 12 litres per kilogram water use would use about 96 litres per cycle (8 kg x 12 litres/kg). Washing Machine Capacity (kg)Average Water Usage per Cycle (litres)540 – 75756 – 105972 – 1351188 – 165 Understanding your washing machine's water use helps you make better laundry choices. It lets you save water and support a greener lifestyle. The washing machine is often a big user of water in a home, using more than a 10-minute shower. But, the latest high-efficiency washing machines are a great way to save water. These machines use new technologies to save a lot of water compared to old ones. They have smart sensors, better water intake, and efficient cycles. This can cut water use by up to 50% or more. An 8kg Samsung washing machine uses only 50 litres per cycle. This is much less than the 100 litres older machines use. This saves the environment and also means big savings for homeowners. Smart sensors that detect the load size and adjust water levels accordingly Efficient wash cycles that minimise water usage without compromising cleaning performance Advanced technologies that recycle and reuse water within the machine Buying a high-efficiency washing machine is a big step towards saving water. These machines are great at saving water. They help reduce a home's water use, making a big difference in living sustainably. The debate between top-loading and front-loading washing machines is key in the laundry room. Both have their own benefits, but which one uses less water is the main question. Top-loading machines were once the top choice for many, but front-loading technology has changed that. A top load washing machine water usage calculator shows top-loaders use up to 40 gallons per cycle. Front-loaders, on the other hand, use as little as 15 gallons for a 7kg front load washing machine. Front-loaders use less water because of their design. They tumble clothes, needing less water to clean. Top-loaders, with their central agitator, use more water to wash clothes. Other factors like load size, cycle choice, and water pressure also affect water use. Yet, front-loading washers are generally more efficient. They are a better choice for those who care about the environment. Washing machines are a big part of our daily lives. But have you ever thought about how much water they use? Knowing how much water your washing machine uses can help you change your laundry habits. This could also save you money on your bills. Many people worry that their washing machine uses too much water. This can depend on the machine's age, how full it is, and the cycle you choose. New, high-efficiency machines use much less water than old ones. They can use as little as 15-25 litres per cycle. An 8kg Bosch washing machine might use about 45 litres of water per cycle. This depends on the settings and programme you pick. An older, less efficient machine could use twice as much water. This is something to think about if you want to use less water. Washing Machine SizeAverage Water Usage (Litres)6kg Capacity35-50 litres8kg Capacity45-65 litres10kg Capacity55-75 litres Knowing how much water washing machines use helps UK consumers make better choices. They can pick a new machine or change their laundry habits to use less water. Adopting water-wise laundry habits is key for the environment and saving money. It's all about making the most of load size and choosing the right cycle. The size of your laundry load affects how much water your washing machine uses. A 7kg washing machine might use about 45 litres per cycle. But a 9kg washing machine could use up to 90 litres. By managing your load size and not overloading, you can use less water without losing cleaning power. Choosing the right wash cycle is also important. The quick wash setting uses less water than longer cycles. Generally, the more intense the cycle, the more water it uses. Wash full loads whenever you can to use your machine efficiently. Make sure the load size fits your washing machine's capacity. Use the quick wash or eco-friendly cycles to cut down on water. Think about the water usage when buying a new washing machine. Modern, efficient models can save you lots of litres each year. "Adopting water-wise laundry habits not only benefits the environment but also translates to tangible cost savings on your utility bills." By following these tips, you can greatly reduce the water your laundry uses. This helps make a better future for everyone. This guide has shown us how important it is to use water wisely when doing laundry. By knowing how much water different machines use and how to choose the right cycle, we can all help the planet. In the UK, making smart choices about our washing machines can really cut down on water use. Thinking about getting a new washing machine with a 7kg capacity? Or maybe you want to use less water with your current one? The tips in this article can help you save a lot of water. By looking at how much water each load uses and changing your habits, you're helping the environment. Even small changes can have a big effect. Using less water means lower bills and helps protect our water supply. Let's all try to be more careful with our laundry to make a greener future. Together, we can make a big difference in how we use water. A 7 kg washing machine uses about 40 to 80 litres of water per load. This depends on the machine and the cycle you choose. To find out how much water a washing machine uses, look at its capacity, the cycle you pick, and any water-saving features. You can usually find this info in the product details or on the manufacturer's website. Washing machines use different amounts of water. This depends on their size, the cycle you use, and if they save water. On average, a standard machine uses 40 to 90 litres per load. An 8 kg machine usually uses 45 to 100 litres of water per load. This can change based on the model and cycle you pick. A 7.5 kg machine uses about 45 to 90 litres of water per load. This depends on its efficiency and the cycle you choose. A 7 kg machine can use 40 to 80 litres of water per load. More efficient models might use less water. Yes, quick wash cycles use less water than regular or heavy-duty cycles. They're made to use less water and energy, making them more eco-friendly. Washing machine cycles use different amounts of water. On average, a cycle can use 40 to 90 litres of water. This depends on the machine's size, the cycle you pick, and how efficient it is. A 10-minute shower can use about 80 to 150 litres of water. This depends on the shower head and water pressure. UK washing machines use 40 to 100 litres of water per load. More efficient machines use less, while older or less efficient ones use more. Your machine might be using too much water for several reasons. It could be a faulty water level sensor, a blocked drain, or an inefficient cycle. Check the manufacturer's guidelines or get help from a professional to fix it. In a home, toilets, showers, and washing machines use the most water. Toilets and showers use the most, followed by washing machines and other appliances. An 8 kg Samsung machine uses 50 to 90 litres of water per load. This can vary based on the model and cycle you choose. A 9 kg machine uses 60 to 100 litres of water per load. More efficient models use less. An 8 kg Bosch machine uses 50 to 90 litres of water per load. This can change based on the model you have. An 8.5 kg machine uses 55 to 100 litres of water per load. This depends on its efficiency and the cycle you pick. A 6.5 kg machine uses 40 to 80 litres of water per load. More efficient models use less. Washing clothes needs different amounts of water. On average, a load uses 40 to 90 litres of water. This depends on the machine's size, efficiency, and the cycle you choose. It's not recommended to wash a king-size duvet in an 8 kg machine. The duvet might be too big and heavy. Check the manufacturer's guidelines or use a bigger machine for a safe and thorough wash. A 7 kg front-load machine uses 35 to 60 litres of water per load. They're usually more efficient than top-load models of the same size. Front-loading washing machines are the most water-efficient. High-efficiency front-loaders use 35 to 50 litres of water per load. They're the best choice for saving water. Your washer might take 2 hours for several reasons. It could be a heavy-duty cycle, a big or dirty load, saving energy, or a faulty part. Check the guidelines or get professional help to find out and fix the issue. 30 minutes isn't enough for a deep clean. It might not let the detergent work well on clothes. Experts suggest at least 45 minutes to an hour for a thorough wash. A 20-minute wash cycle is often too short. It might not clean clothes well, especially if they're heavily soiled. For best results, use a cycle of at least 45 minutes to an hour. Machine that washes clothes For other uses, see Washing machine (disambiguation). Not to be confused with Dishwasher. LG washing machine (c. 2010) A washing machine (laundry machine, clothes washer, washer, or simply wash) is a machine designed to launder clothing. The term is mostly applied to machines that use water. Other ways of doing laundry include dry cleaning (which uses alternative cleaning fluids and is performed by specialist businesses) and ultrasonic cleaning. Modern-day home appliances use electric power to automatically clean clothes. The user adds laundry detergent, which is sold in liquid, powder, or dehydrated sheet form, to the wash water. The machines are also found in commercial laundromats where customers pay-per-use. Main article: Laundry § History An early Miele washing machine at the Roscheider Hof Open Air Museum, Germany, showing farming traditions of the Irrel region. Laundering by hand involves soaking, beating, scrubbing, and rinsing dirty textiles. Before indoor plumbing, it was necessary to carry all the water used for washing, boiling, and rinsing the laundry from a pump, well, or spring. Water for the laundry would be hand-carried, heated on a fire for washing, and then poured into a tub. This meant the amount of warm, soapy water was limited; it would be reused to wash the least soiled clothing, then to wash progressively dirtier laundry. Removal of soap and water from the clothing after washing was a separate process. First, soap would be rinsed out with clear water. After rinsing, the soaking wet clothing would be formed into a roll and twisted by hand to extract water. The entire process often occupied an entire day of work, plus drying and ironing. A 1766 illustration of Schäffer's washing machine (left) and a simple, crank-operated washing machine (right) The examples and perspective in this article deal primarily with the United States and do not represent a worldwide view of the subject. You may improve this article, discuss the issue on the talk page, or create a new article, as appropriate. (September 2016) (Learn how and when to remove this message) Wringer washer, Paspébiac, Québec, Canada A fulling mill from Georg Andreas Böckler's Theatrum Machinarum Novum, 1661 An early example of washing by machine is the practice of fulling. In a fulling mill, the cloth was beaten with wooden hammers, known as fulling stocks or fulling hammers. The first English patent under the category of washing machines was issued in 1691.[1] A drawing of an early washing machine appeared in the January 1752 issue of The Gentleman's Magazine, a British publication.[citation needed] Jacob Christian Schäffer's washing machine design was published in 1767[citation needed] in Germany.[2] In 1782, Henry Sidgier was issued a British patent for a rotating drum washer, and in the 1790s, Edward Beetham sold numerous "patent washing mills" in England.[3] One of the first innovations in washing machine technology was the use of enclosed containers or basins that had grooves, fingers, or paddles to help with the scrubbing and rubbing of the clothes. The person using the washer would use a stick to press and rotate the clothes along the textured sides of the basin or container, agitating the clothes to remove dirt and mud.[4] This crude agitator technology was hand-powered, but still more effective than actually hand-washing the clothes. More advancements were made to washing machine technology in the form of the rotating drum design. These early design patents consisted of a drum washer that was hand-cranked to make the wooden drums rotate. While the technology was simple enough, it was a milestone in the history of washing machines, as it introduced the idea of "powered" washing drums. As metal drums started to replace the traditional wooden drums, it allowed for the drum to turn above an open fire or an enclosed fire chamber, raising the water temperature for more effective washes. It was in the nineteenth century that steam power was first used in washing machine designs.[5] In 1862, a patented "compound rotary washing machine, with rollers for wringing or mangling" by Richard Lansdale of Pendleton, Manchester, was shown at the 1862 London Exhibition.[6] The first United States Patent, titled "Clothes Washing", was granted to Nathaniel Briggs of New Hampshire in 1797. Because of the Patent Office fire in 1836, no description of the device survives. The invention of the washing machine is also attributed to Watervliet Shaker Village, as a patent was issued to an Amos Larcom of Watervliet, New York, in 1829, but it is not certain that Larcom was a Shaker.[7] A device that combined a washing machine with a wringer mechanism appeared in 1843 when Canadian John E. Turnbull of Saint John, New Brunswick patented a "Clothes Washer With Wringer Rolls".[8] During the 1850s, Nicholas Bennett of the Mount Lebanon Shaker Society at New Lebanon, New York, invented a "wash mill", but in 1858 he assigned the patent to David Parker of the Canterbury Shaker Village, where it was registered as the "Improved Washing Machine".[9][10][11] A 1923 electric Miele washing machine with a built-in mangle for drying Margaret Colvin improved the Triumph Rotary Washer,[12] which was exhibited in the Women's Pavilion at the Centennial International Exhibition of 1876 in Philadelphia.[13] At the same exhibition, the Shakers won a gold medal for their machine.[7] Electric washing machines were advertised and discussed in newspapers as early as 1904.[14] Alva J. Fisher has been incorrectly credited with the invention of the electric washer. The US Patent Office shows at least one patent issued before Fisher's US patent number 966677[15] (e.g. Woodrow's US patent number 921195).[16] The first inventor of the electric washing machine remains unknown.[citation needed] US electric washing machine sales reached 913,000 units in 1928. However, high unemployment rates in the Depression years reduced sales; by 1932 the number of units shipped was down to about 600,000. An early laundromat in the United States opened in Fort Worth, Texas, in 1934.[17][dubious – discuss] It was run by Andrew Klein. Patrons used coin-in-the-slot facilities to rent washing machines. The term "laundromat" can be found in newspapers as early as 1884 and they were widespread during the Depression. England established public washrooms for laundry along with bathhouses throughout the nineteenth century.[18] Washer design improved during the 1930s. The mechanism was now enclosed within a cabinet, and more attention was paid to electrical and mechanical safety. Spin dryers were introduced to replace the dangerous power mangle/wringers of the day. By 1940, 60% of the 25,000,000 wired homes in the United States had an electric washing machine. Many of these machines featured a power wringer, although built-in spin dryers were not uncommon.[citation needed] The Washing Machine Museum in Mineral Wells, Texas Bendix Home Appliances, a subsidiary of Avco, introduced the first domestic automatic washing machine in 1937,[19] having applied for a patent in the same year.[20] Avco had licensed the name from Bendix Corporation, an otherwise unrelated company. In appearance and mechanical detail, this first machine was not unlike the front-loading automatic washers produced today. Although it included many of today's basic features, the machine lacked any drum suspension and therefore had to be anchored to the floor to prevent "walking". Because of the components required, the machine was also expensive. For instance, the Bendix Home Laundry Service Manual (published November 1, 1946) shows that the drum speed change was facilitated by a 2-speed gearbox built to a heavy-duty standard (not unlike a car automatic gearbox, albeit smaller in size). The timer was also probably costly because miniature electric motors were expensive to produce. Early automatic washing machines were usually connected to a water supply via temporary slip-on connectors to sink taps. Later, permanent connections to hot and cold water became the norm. Most modern front-loading European machines now only have a cold water connection (called "cold fill") and rely completely on internal electric heaters to raise the water temperature.[21] Many of the early automatic machines had coin-in-the-slot facilities and were installed in the basement laundry rooms of apartment houses. Automatic washing machine fittings.On the left is a ball valve from the water supply and a water inlet hose.On the right is a drainage pipe made of PVC pipes, to which a drain hose is connected. A Hoover 0307, manufactured from 1947 to 1957 After the attack on Pearl Harbor, US domestic washer production was suspended for the duration of World War II in favor of manufacturing war material. However, numerous US appliance manufacturers were permitted to undertake the research and development of washers during the war years. Many took the opportunity to develop automatic machines, realizing that these represented the future of the industry.[22] A large number of US manufacturers introduced competing automatic machines (mainly of the top-loading type) in the late 1940s and early 1950s. General Electric also introduced its first top-loading automatic model in 1947. This machine had many of the features that are incorporated into modern machines. Another early form of automatic washing machine manufactured by The Hoover Company used cartridges to program different wash cycles. This system, called the "Keymatic", used plastic cartridges with key-like slots and ridges around the edges. The cartridge was inserted into a slot on the machine and a mechanical reader operated the machine accordingly. Several manufacturers produced semi-automatic machines, requiring the user to intervene at one or two points in the wash cycle. A common semi-automatic type (available from Hoover in the UK until at least the 1970s) included two tubs: one with an agitator or impeller for washing, plus another smaller tub for water extraction or centrifugal rinsing.[citation needed] These machines, as well as other older designs like the manual rotating drum, are still available, but are typically only used in circumstances where a standard water and power hookup for a washing machine is unavailable. Many are marketed for camping due to their light weight and ability to function without a water connection. A 1950s model Constructa Since their introduction, automatic washing machines have relied on electromechanical timers to sequence the washing and extraction process. Electromechanical timers consist of a series of cams on a common shaft driven by a small electric motor via a reduction gearbox. At the appropriate time in the wash cycle, each cam actuates a switch to engage or disengage a particular part of the machinery (for example, the drain pump motor). One of the first was invented in 1957 by Winston L. Shelton and Gresham N. Jennings, then both General Electric engineers. The device was granted US Patent 2870278.[23] On the early electromechanical timers, the motor ran at a constant speed throughout the wash cycle, although the user could truncate parts of the program by manually advancing the control dial. However, by the 1950s demand for greater flexibility in the wash cycle led to the introduction of more sophisticated electrical timers to supplement the electromechanical timer. These newer timers enabled greater variation in functions such as the wash time. With this arrangement, the electric timer motor is periodically switched off to permit the clothing to soak and is only re-energized just before a micro-switch being engaged or disengaged for the next stage of the process. Fully electronic timers did not become widespread until decades later. Despite the high cost of automatic washers, manufacturers had difficulty meeting the demand. Although there were material shortages during the Korean War, by 1953 automatic washing machine sales in the US exceeded those of wringer-type electric machines. In the UK and most of Europe, electric washing machines did not become popular until the 1950s. This was largely because of the economic impact of World War II on the consumer market, which did not properly recover until the late 1950s. The early electric washers were single-tub wringer-type machines, as fully automatic washing machines were expensive. During the 1960s, twin tub machines briefly became popular, helped by the low price of the Rolls Razor washers. Twin tub washing machines have two tubs, one larger than the other. The smaller tub in reality is a spinning drum for centrifugal drying while the larger tub only has an agitator in its bottom. Some machines could pump used wash water into a separate tub for temporary storage and to later pump it back for re-use. This was done not to save water or soap, but because heated water was expensive and time-consuming to produce. Automatic washing machines did not become dominant in the UK until well into the 1970s and by then were almost exclusively of the front-loader design. In early automatic washing machines, any changes in impeller/drum speed were achieved by mechanical means or by a rheostat on the motor power supply. However, since the 1970s electronic control of motor speed has become a common feature on the more expensive models. Over time manufacturers of automatic washers have gone to great lengths to reduce costs. For instance, expensive gearboxes are no longer required, since motor speed can be controlled electronically. Some models can be controlled via WiFi, and have angled/tilted drums to facilitate loading.[24][25][26] Even on some expensive washers, the outer drum of front-loading machines is often (but not always) made of plastic (it can also be made out of metal, but this is expensive). This makes changing the main bearings difficult, as the plastic drum usually cannot be separated into two halves to enable the inner drum to be removed to gain access to the bearing. Many residential front-loading washing machines typically have a 25 kg (55 lb) concrete block to dampen vibration.[27] Alternatives include a plastic counterweight that can be filled with water after delivery,[27] reducing or controlling motor speeds, using hydraulic suspensions instead of spring suspensions, and having freely moving steel balls or liquid contained inside a ring mounted on both the top and bottom of the drum to counter the weight of the clothes and reduce vibration.[28][29] Most newer front-load machines now use a brushless DC (BLDC) motor directly connected to the basket (direct drive), where the stator assembly is attached to the rear of the outer plastic drum assembly, whilst the co-axial rotor is mounted on the shaft of the inner drum.[30] The direct drive motor eliminates the need for a pulley, belt, and belt tensioner.[31][32][33][34][35] It was first introduced to washing machines by Fisher and Paykel in 1991. Since then, other manufacturers have followed suit. Some washing machines with this type of motor now come with 10-year or 20-year warranties.[36][37] The motor type used is an outrunner, due to its slim design with variable speed and high torque. The rotor is connected to the inner tub through its center. It can be made of metal or plastic. Some direct drive washers use induction motors instead of BLDC motors.[38] The modern washing machine market has seen several innovations and features, examples including: Washing machines including water jets (also known as water sprays, jet sprays[39] and water showers) and steam nozzles[40] that claim to sanitize clothes, help reduce washing times, and remove soil from the clothes.[41] Water jets get their water from the bottom of the drum, thus recirculating the water in the washer.[42][43][44] Others have special drums with holes that will fill with water from the bottom of the tub and redeposit the water on top of the clothes. Some drums have elements with the shape of waves, pyramids, hexagons, domes, or diamonds.[45][46][47][48] Some include titanium or ceramic heating elements that claim to eliminate calcium buildup in the element.[49] They can heat water up to 95 °C (203 °F). Some high-end models have lights built into the washer itself to light the drum,[40] Others have soap dispensers where the user fills a tank[50][51] with detergent and softener and the washing machine automatically doses the detergent and softener[52] and, in some cases, chooses the most appropriate wash cycle.[53] In some models, the tanks come pre-filled and are installed and replaced with new tanks, also pre-filled or refilled by the user, in a dedicated compartment on the bottom of the machine.[54] Some have support for single-use capsules containing enough laundry additives for one load. The capsules are installed in the detergent compartment.[55][56] Many dilute the detergent before it comes in contact with the clothes,[57][58][59][60][61] some by means of mixing the soap and water with air to make foam,[62] which is then introduced into the drum and improves cleaning performance.[63][64][65][66] Alternatively, micro bubbles may be used instead.[67][68] Some have pulsators that are mounted on a plate on the bottom of the drum instead of an agitator.[69][70][71] The plate spins, and the pulsators generate waves that help shake the soil out of the clothes. Many also include mechanisms to prevent or remove undissolved detergent residue on the detergent dispenser.[72][73][74] It is possible to incorporate a blower and a nozzle to smooth wrinkles in clothes without removing them from the washer.[75][76] Some manufacturers like LG Electronics and Samsung Electronics have introduced functions on their washers that allow users to troubleshoot common problems with their washers without having to contact technical support. LG's approach involves a phone receiving signals through sound tones, while Samsung's approach involves having the user take a photo of the washer's time display with a phone. In both methods, the problem and steps to resolve it are displayed on the phone itself.[77][78] Some models are also NFC enabled.[79] Some implementations are patented under US Patent US20050268669A1 and US Patent US20050097927A1. A see-through Bosch machine at the IFA 2010 in Berlin shows its internal components. In 1976 Servis released the world's first microcontroller operated washing machine, the Servis Selectronic 301.[80][81] In 1980 Hotpoint (UK) were the second manufacturer to produce a microcontroller based washing machine, the first of their top of line Microtronic series, the Hotpoint Microtronic X2000[82][83] both used chips from the Texas Instruments TMS1000 family of microcontrollers. In the early 1990s, upmarket machines incorporated microcontrollers for the timing process. These proved reliable and cost-effective, so many cheaper machines now also incorporate microcontrollers rather than electromechanical timers. Since the 2010s, some machines have had touchscreen displays, full-color or color displays, or touch-sensitive control panels.[84][85] In 1994, Staber Industries released the System 2000 washing machine, which is the only top-loading, horizontal-axis washer to be manufactured in the United States. The hexagonal tub spins like a front-loading machine, using only about one-third as much water as conventional top-loaders. This factor has led to an Energy Star rating for its high efficiency. This type of horizontal-axis washer and dryer (with a circular drum) is often used in Europe, where space is limited, as they can be as thin as 41 cm (16 in) in width.[86] In 1998, New Zealand-based company Fisher & Paykel introduced its SmartDrive washing machine line in the US. This washing machine uses a computer-controlled system to determine factors such as load size and adjusts the wash cycle to match. It also used a mixed system of washing, first with the "Eco-Active" wash, using a low level of recirculated water being sprayed on the load followed by a more traditional style wash. The SmartDrive also included a direct drive brushless DC electric motor, which simplified the bowl and agitator drive by eliminating the gearbox system. In 2000, the British inventor James Dyson launched the CR01 ContraRotator, a type of washing machine with two cylinders rotating in opposite directions. It was claimed that this design reduced the wash time and produced cleaner washing than a single-cylinder machine. In 2004 the launch of the CR02, was the first washing machine to gain the British Allergy Foundation Seal of Approval. However, neither of the ContraRotator machines is now in production as they were expensive to manufacture. They were discontinued in 2005.[87][88] It is patented under U.S. Patent US7750531B2, U.S. Patent US6311527, U.S. Patent US20010023513, U.S. Patent US6311527B1, U.S. Patent USD450164.[89] In 2001, Whirlpool Corporation introduced the Calypso, the first vertical-axis high-efficiency washing machine to be top-loading. A washplate in the bottom of the tub nutated (a special wobbling motion) to bounce, shake, and toss the laundry. Simultaneously, water containing detergent was sprayed onto the laundry. The machine proved to be good at cleaning but gained a bad reputation due to frequent breakdowns and destruction of laundry. The washer was recalled with a class-action lawsuit[90] and pulled off the market. A Beko washing machine; modern household washing machines start at 1 kg (2 lb) capacity, designed for smaller households, and span to 24 kg (53 lb) load capacity. In 2003, Maytag introduced their top-loading Neptune TL FAV6800A and TL FAV9800A washers. Instead of an agitator, the machine had two washplates, perpendicular to each other and at a 45-degree angle from the bottom of the tub. The machine would fill with only a small amount of water and the two wash plates would spin, tumbling the load within it, mimicking the action of a front-loading washer in a vertical-axis design.[91][92][93][94][95][96] In 2006, Sanyo introduced the "world-first" (as of February 2, 2006, with regards to home use drum-type washer/dryer) drum-type washing machine with "Air Wash" function (i.e.: using ozone as a disinfectant). It also reused and disinfected rinse water.[97] This washing machine uses only 50 L (11.0 imp gal; 13.2 US gal) of water in the recycle mode. Approximately in 2012, eco-indicators were introduced, capable of predicting the energy demand based on the customer settings in terms of program and temperature.[98] Features available in most modern consumer washing machines: Delayed execution: a timer to delay the start of the laundry cycle Predefined programs for different laundry types Rotation speed settings

Variable temperatures, including cold wash Additionally, some modern machines feature: Child lock[99] Steam Time remaining indication Extra water/rinse. UV disinfection.[100] Around 2015 and 2017, some manufacturers[101][102][103] (namely Samsung and LG Electronics) offered washers and dryers that either have a top-loading washer and dryer built on top of a front-loading washer and dryer respectively (in Samsung washers and dryers) or offer users an optional top-loading washer that can be installed under a washer or dryer (for LG washers and dryers) Both manufacturers have also introduced front-loading washers allowing users to add items after a wash cycle has started,[104][105] and Samsung has also introduced top-loading washers with a built-in sink[106] and a detergent dispenser that claims to leave no residue on the dispenser itself. In IFA 2017,[107] Samsung released the QuickDrive, a front-loading washer similar to the Dyson ContraRotator but instead of two counter-rotating drums, the QuickDrive has a single drum with a counter-rotating impeller mounted on the back of the drum. Samsung claims this technique reduces cycle times by half and energy consumption by 20%. The US has introduced standards for washing machines that improve their energy efficiency and reduce their water consumption.[108][109] General Electric Filter-Flo top-loading, vertical-axis machines installed in a laundromat. The pans on the inside of the lid are placed atop the agitator, and wash water is pumped through the perforated pans to collect lint. (California) In a top-loading washer, water circulates primarily along the poloidal axis during the wash cycle, as indicated by the red arrow in this illustration of a torus. The top-loading, vertical-axis washer has been the dominant design in the United States and Canada. This design places the clothes in a vertically mounted perforated basket that is contained within a water-retaining tub, with a finned water-pumping agitator in the center of the bottom of the basket. Clothes are loaded through the top of the machine, which is usually but not always covered with a hinged door. The drum of a top loading washing machine can include a lint trap.[110] During the wash cycle, the outer tub is filled with water sufficient to fully immerse and suspend the clothing freely in the basket. The movement of the agitator pushes water outward between the paddles towards the edge of the tub. The water then moves outward, up the sides of the basket, towards the center, and then down towards the agitator to repeat the process, in a circulation pattern similar to the shape of a torus. The agitator direction is periodically reversed because continuous motion in one direction would just lead to the water spinning around the basket with the agitator rather than the water being pumped in the torus-shaped motion. Some washers supplement the water-pumping action of the agitator with a large rotating screw on the shaft above the agitator, to help move water downwards in the center of the basket. A washing machine can have an impeller, also called a wash plate, instead of an agitator, which serves the same purpose but does not have a vertical cylinder extending from its base. Since the agitator and the drum are separate and distinct in a top-loading washing machine, the mechanism of a top-loader is inherently more complicated than a front-loading machine. Manufacturers have devised several ways to control the motion of the agitator during the wash and rinse separately from the high-speed rotation of the drum required for the spin cycle. While a top-loading washing machine could use a universal motor or DC brushless motor, it is conventional for top-loading washing machines to use more expensive, heavy, and potentially more electrically efficient and reliable induction motors. An alternative to this oscillating agitator design is the impeller-type washtub pioneered by Hoover on its long-running Hoovermatic series of top-loading machines. Here, an impeller (trademarked by Hoover as a "Pulsator") mounted on the side of the tub spins in a constant direction and creates a fast-moving current of water in the tub which drags the clothes through the water along a toroidal path. This design was used in the Hoover 0307 washer. The impeller design has the advantage of mechanical simplicity – a single-speed motor with belt drive is all that is required to drive the Pulsator with no need for gearboxes or complex electrical controls, but has the disadvantage of lower load capacity in relation to tub size. Hoovermatic machines were made mostly in twin-tub format for the European market (where they competed with Hotpoint's Supermatic line which used the oscillating agitator design) until the early 1990s. Some industrial garment testing machines still use the Hoover wash action. Another alternative involves 'pulsating' the agitator, in other words having an agitator with a reciprocating motion along its vertical axis.[111] Some washing machines have agitators that move in an orbiting motion[112][113][114] or agitators that nutate at the bottom.[115][116][117][118][119] Special top loading washing machines designed for washing sneakers can incorporate bristles in their agitators.[120] Alternatively the inner tub itself can nutate inside the outer tub.[121][122] The many different ways manufacturers have solved the same problem over the years is a good example of many different ways to solve the same engineering problem with different goals, different manufacturing capabilities and expertise, and different patent encumbrances. In many current top-loading washers, if the motor spins in one direction, the gearbox drives the agitator; if the motor spins the other way, the gearbox locks the agitator and spins the basket and agitator together. Similarly, if the pump motor rotates one way it recirculates the sudsy water; in the other direction it pumps water from the machine during the spin cycle. Mechanically, this system is very simple.[38] In some top-loaders, the motor runs only in one direction. During agitation, the transmission converts the rotation into the alternating motion driving the agitator. During the spin cycle, the timer turns on a solenoid which engages a clutch locking the motor's rotation to the wash basket, providing a spin cycle. General Electric's very popular line of Filter-Flo (seen to the right) used a variant of this design where the motor reversed only to pump water out of the machine. The same clutch which allows the heavy tub full of wet clothes to "slip" as it comes up to the motor's speed, is also allowed to "slip" during agitation to engage a Gentle Cycle for delicate clothes. Whirlpool (Kenmore) created a popular design demonstrating the complex mechanisms which could be used to produce different motions from a single motor with the so-called "wig wag" mechanism, which was used for decades until modern controls rendered it obsolete. In the Whirlpool mechanism, a protruding moving piece oscillates in time with the agitation motion. Two solenoids are mounted to this protruding moving piece, with wires attaching them to the timer. During the cycle, the motor operates continuously, and the solenoids on the "wig wag" engage in agitation or spin. Despite the wires controlling the solenoids being subject to abrasion and broken connections due to their constant motion and the solenoids operating in a damp environment where corrosion could damage them, these machines were surprisingly reliable. Some top-loaders, especially compact apartment-sized washers, use a hybrid mechanism. The motor reverses direction every few seconds, often with a pause between direction changes, to perform the agitation. The spin cycle is accomplished by engaging a clutch in the transmission. A separate motorized pump is generally used to drain this style of machine. These machines could easily be implemented with universal motors or more modern DC brushless motors, but older ones tend to use a capacitor-start induction motor with a pause between reversals of agitation.[123] Arctic BE1200A+ is a front-loading budget model sold in 2008 with 6-kilogram (13 lb) load, LCD indicator, operating up to 1200 RPM. Modern drum of front-loading washing machine (Bosch Maxx WFO 2440) The front-loading or horizontal-axis clothes washer is the dominant design in Europe and in most parts of the world. In the United States and Canada, most "high-end" washing machines are of this type. In addition, most commercial and industrial clothes washers around the world are of the horizontal-axis design. This layout mounts the inner drum and outer drum horizontally, and loading is through a door at the front of the machine. The door often but not always contains a transparent window. Agitation is supplied by the back-and-forth rotation of the cylinder and by gravity. The clothes are lifted by paddles on the inside wall of the drum and then dropped. This motion flexes the weave of the fabric and forces water and detergent solution through the clothes load. Because the wash action does not require the clothing to be freely suspended in water, only enough water is needed to moisten the fabric. Because less water is required, front-loaders typically use less soap, and the repeated dropping and folding action of the tumbling can easily produce large amounts of foam or suds. Front-loaders control water usage through the surface tension of water, and the capillary wicking action this creates in the fabric weave. A front-loader washer always fills to the same low water level, but a large pile of dry clothing standing in water will soak up the moisture, causing the water level to drop. The washer then refills to maintain the original water level. Because it takes time for this water absorption to occur with a motionless pile of fabric, nearly all front-loaders begin the washing process by slowly tumbling the clothing under the stream of water entering and filling the drum, to rapidly saturate the clothes with water. Compared to top-loading washers, clothing can be packed more tightly in a front loader, up to the full drum volume if using a cotton wash cycle. This is because wet cloth usually fits into a smaller space than dry cloth, and front-loaders can self-regulate the water needed to achieve correct washing and rinsing. However, extreme overloading of front-loading washers pushes fabrics towards the small gap between the loading door and the front of the inner drum, potentially resulting in fabrics lost between the inner drum and outer tub, and in severe cases, tearing of clothing and jamming the motion of the inner drum. Front-loading washers are mechanically simple compared to top-loaders, with the main motor (a universal motor or variable-frequency drive motor) normally being connected to the drum via a grooved pulley belt and large pulley wheel without the need for a gearbox, clutch or crank. The action of a front-loading washing machine is better suited to a motor capable of reversing direction with every reversal of the wash drum; a universal motor is noisier, less efficient, and does not last as long, but is better suited to the task of reversing direction every few seconds. Some models, such as those by LG, use a motor directly connected to the drum, eliminating the need for a belt and pulley. However, front-load washers suffer from their own technical challenges due to the horizontal disposition of the drum. A top-loading washer keeps water inside the tub merely through the force of gravity pulling down on the water, while a front-loader must tightly seal the door with a gasket to prevent water dripping onto the floor during the wash cycle. This access door is locked shut with an interlocking device during the entire wash cycle, since opening the door with the machine in use could result in water gushing onto the floor. If this interlock is broken for any reason, such a machine stops operation, even if this failure happens mid-cycle. In most machines, the interlock is usually doubly redundant to prevent either opening with the drum full of water or being opened during the spin cycle. For front-loaders without viewing windows on the door, it is possible to accidentally pinch the fabric between the door and the drum, resulting in tearing and damage to the pinched clothing during tumbling and spinning. Nearly all front-loader washers for the consumer market also use a folded flexible bellows assembly around the door opening to keep clothing contained inside the drum during the tumbling wash cycle. If this bellows assembly were not used, small articles of clothing such as socks could slip out of the wash drum near the door and fall down the narrow slot between the outer and inner drums, plugging the drain and possibly jamming rotation of the inner drum. Retrieving lost items from between the outer drum and inner drum can require complete disassembly of the front of the washer and pulling out the entire inner wash drum. Commercial and industrial front-loaders used by businesses (described below) usually do not use the bellows, but instead require all small objects to be placed in a mesh bag to prevent loss near the drum opening. European top-loader with horizontal-axis rotating drum (2008) There are many variations of the two general designs. Top-loading machines in Asia use impellers instead of agitators. Impellers are similar to agitators except that they do not have the center post extending up in the middle of the washtub basket. Some machines which load from the top are otherwise much more similar to front-loading horizontal-axis drum machines. They have a drum rotating around a horizontal axis, as a front-loader, but there is no front door; instead, there is a liftable lid that provides access to the drum, which has a hatch that can be latched shut. Clothes are loaded, the hatch and lid are closed, and the machine operates and spins just like a front loader. These machines are narrower but usually taller than front-loaders, usually have a lower capacity, and are intended for use where only a narrow space is available, as is sometimes the case in Europe. They have incidental advantages: they can be loaded while standing (but force the user to bend down instead of crouching down or sitting to unload); they do not require a perishable rubber bellows seal; and instead of the drum having a single bearing on one side, it has a pair of symmetrical bearings, one on each side, avoiding asymmetrical bearing loading and potentially increasing life. There are also combo washer dryer machines that combine washing cycles and a full drying cycle in the same drum, eliminating the need to transfer wet clothes from a washer to a dryer machine. In principle, these machines are convenient for overnight cleaning (the combined cycle is considerably longer), but the effective capacity for cleaning larger batches of laundry is drastically reduced. The drying process tends to use much more energy than using two separate devices, because a combo washer dryer not only must dry the clothing but also needs to dry out the wash chamber itself. These machines are used more where space is at a premium, such as areas of Europe and Japan because they can be fit into small spaces, perform both washing and drying, and many can be operated without dedicated utility connections. In these machines, the washer and dryer functions often have different capacities, with the dryer usually having the lowest capacity. These combo machines should not be confused with a dryer on top of a washer installation, or with a laundry center, which is a one-piece appliance offering a compromise between a washer-dryer combo and a full washer to the side of the dryer installation or a dryer on top of a washer installation. Laundry centers usually have the dryer on top of the washer, with the controls for both machines being on a single control panel. Often, the controls are simpler than the controls on a washer-dryer combo or a dedicated washer and dryer. Some implementations are patented under US Patent US6343492B1 and US Patent US 6363756B1. True front-loading machines, top-loading machines with horizontal-axis drums, and true top-loading vertical-axis machines can be compared on several aspects: Efficient cleaning: Front loaders usually use less energy, water, and detergent compared to the best top-loaders.[124] High-efficiency washers use 20% to 60% of the detergent, water, and energy of "standard" commonly-used top-loader washers. They usually take somewhat longer (20–110 minutes) to wash a load, but are often computer controlled with additional sensors, to adapt the wash cycle to the needs of each load. Water usage: Front-loaders usually use less water than top-loading residential clothes washers. Estimates are that front-loaders use from one-third [125] to one half[126] as much water as top-loaders. Spin-dry effectiveness: Front-loaders (and European horizontal-axis top-loaders and some front-loaders) offer much higher maximum spin speeds of up to 2000 RPM, although home machines tend to be in the 1000 to 1400 RPM range, while top-loaders (with agitators) do not exceed 1140 RPM. High-efficiency top-loaders with a wash plate (instead of an agitator) can spin up to 1100 RPM, as their center of gravity is lower. Higher spin speeds, along with the diameter of the drum, determine the g-force, and a higher g-force removes more residual water, making clothes dry faster. This also reduces energy consumption if clothes are dried in a clothes dryer.[127] Cycle length: Top-loaders have tended to have shorter cycle times, in part because their design has traditionally emphasized simplicity and speed of operation more than resource conservation. It is observed that top-loaders wash the clothes in half the time as compared to a front-load washing machine. Wear and abrasion: Top-loaders require an agitator or impeller mechanism to force enough water through clothes to clean them effectively, which greatly increases mechanical wear and tear on fabrics. Front-loaders use paddles in the drum to repeatedly pick up and drop clothes into the water for cleaning; this gentler action causes less wear and tear. The rate of clothes wear can be roughly gauged by the amount of accumulation in a clothes dryer lint filter, since the lint largely consists of stray fibers detached from textiles during washing and drying. Difficult items: Top-loaders may have trouble cleaning large items, such as sleeping bags or pillows, which tend to float on top of the wash water rather than circulate within it. In addition, vigorous top-loader agitator motions may damage delicate fabrics. Whereas in a front-load washing machine, one can easily wash pillows, shoes, soft toys, and other difficult-to-wash items. Noise: Front-loaders tend to operate more quietly than top-loaders because the door seal helps contain noise, and because there is less of a tendency towards imbalance. Top loaders usually need a mechanical transmission (due to agitators, see above), which can generate more noise than the rubber belt or direct drive found in most front-loaders. Compactness: True front-loading machines may be installed underneath counter-height work surfaces. A front-loading washing machine, in a fully fitted kitchen, may even be disguised as a kitchen cabinet. These models can also be convenient in homes with limited floor area, since the clothes dryer may be installed directly above the washer ("stacked" configuration). Water leakage: Top-loading machines are less prone to leakage because simple gravity reliably keeps water from spilling out the loading door on top. True front-loading machines require a flexible seal or gasket on the front door, and the front door must be locked during operation to prevent opening, lest large amounts of water spill out. This seal may leak and require replacement. However, many current front-loaders use so little water that they can be stopped mid-cycle for the addition or removal of laundry, while keeping the water level in the horizontal tub below the door level. Best practice installations of either type of machine will include a floor drain or an overflow catch tray with a drain connection, since neither design is immune to leakage or a solenoid valve getting stuck in the open position. Maintenance and reliability: Top-loading washers are more tolerant of maintenance neglect, and may not need a regular "freshening" cycle to clean door seals and bellows. During the spin cycle, a top-loading tub is free to move about inside the cabinet of the machine, using only a lip around the top of the inner basket and outer tub to keep the spinning water and clothing from spraying out over the edge. Therefore, the potentially problematic door-sealing and door-locking mechanisms used by true front-loaders are not needed. On the other hand, top-loaders use mechanical gearboxes that are more vulnerable to wear than simpler front-load motor drives. Accessibility and ergonomics: Front-loaders are more convenient for shorter people and those with paraplegia, as the controls are front-mounted and the horizontal drum eliminates the need for standing or climbing. Risers, also referred to as pedestals, often with storage drawers underneath, can be used to raise the door of a true front-loader closer to the user's level. However, if stacked, the dryer controls, if at the top of the dryer, may be too tall for shorter people to conveniently access. Initial cost: In countries where top-loaders are popular, front-loaders tend to be more expensive to buy than top-loaders, though their lower operating costs can lead to lower total cost of ownership, especially if energy, detergent, or water are expensive. On the other hand, in countries with a large front-loader user base, top-loaders are usually seen as alternatives and more expensive than basic off-brand front-loaders, although without many differences in total cost of ownership apart from design-originated ones. In addition, manufacturers have tended to include more advanced features such as internal water heating, automatic dirt sensors, and high-speed emptying on front loaders, although some of these features could be implemented on top loaders. German laundry centrifuge to extract water from laundry; the advent of automatic washing machines with spin cycles made such specialized appliances largely obsolete by the 1970s. The earliest washing machines simply carried out a washing action when loaded with clothes and soap, filled with hot water, and started. Over time machines became more and more automated, first with complex electromechanical controllers, then fully electronic controllers; users put clothes into the machine, select a suitable program via a switch, start the machine, and come back to remove clean and slightly damp clothes at the end of the cycle. The controller starts and stops many different processes including pumps and valves to fill and empty the drum with water, heating, and rotating at different speeds, with different combinations of settings for different fabrics. Longer wash cycles can allow greater water and energy efficiency (with less water to heat up). For a 3.5 kg (7.7 lb) load, from 2011 to 2021, the average Australian washing machine cycle (including rinsing and spinning) has lengthened from 99 to 144 minutes for front-loaders, and 55 to 59 minutes for top-loaders.[128] Many front-loading machines have internal electrical heating elements to heat the wash water, to near boiling if desired. The rate of the chemical cleaning action of the detergent and other laundry chemicals increases greatly with temperature, by the Arrhenius equation. Washing machines with internal heaters can use special detergents formulated to release different chemical ingredients at different temperatures, allowing different types of stains and soils to be cleaned from the clothes as the wash water is heated by the electrical heater. However, higher-temperature washing uses more energy, and many fabrics and elastics are damaged at higher temperatures. Temperatures exceeding 40 °C (104 °F) have the undesirable effect of deactivating the enzymes when using biological detergent. Many machines are cold-fill, connected to cold water only, which they internally heat to operating temperature. Where water can be heated more cheaply or with less carbon dioxide emission than by electricity, a cold-fill operation is inefficient. Front-loaders need to use low-sudsing detergents because the tumbling action of the drum entrains air into the clothes load, which can cause excessive foamy suds and overflows. However, due to the efficient use of water and detergent, the suds issue with front-loaders can be controlled by simply using less detergent, without lessening the cleaning action. Washing machines perform several rinses after the main wash to remove most of the detergent. Modern washing machines use less hot water due to environmental concerns; however, this has led to the problem of poor rinsing on many washing machines on the market,[129] which can be a problem to people who are sensitive to detergents. The Allergy UK website suggests re-running the rinse cycle, or rerunning the entire wash cycle without detergent.[130] In response to complaints, many washing machines allow the user to select additional rinse cycles, at the expense of higher water usage and longer cycle time. Bosch, for example, in its allergy wash program, incorporates an additional three-minute rinse cycle with water of at least 60 °C (140 °F) to rinse off detergent residues and any allergens.[131] Front-loading machines spin in multiple stages of their cycle: after main wash, after individual rinses, and the final high-speed spin. Some of those spins may be absent depending on the particular cycle. Higher spin speeds, along with larger tub diameters, remove more water, leading to faster drying. On the other hand, the need for ironing can be reduced by not using the spin cycle in the washing machine. If a heated clothes dryer is used after the wash and spin, energy use is reduced if more water has been removed from clothes. However, faster spinning can crease clothes more. Also, mechanical wear on bearings increases rapidly with rotational speed, reducing life. Early machines would spin at 300 RPM and, because of lack of any mechanical suspension, would often shake and vibrate. In 1976, most front-loading washing machines spun at around 700 RPM, or less.[citation needed] Today, most machines spin at 1000–1600 RPM. Most machines have variable speeds, ranging 300–2000 RPM depending on the machine. Separate spin dryers, without washing functionality, are available for specialized applications. For example, a small high-speed centrifuge machine may be provided in locker rooms of communal swimming pools to allow wet swimsuits to be substantially dried to a slightly damp condition after daily use. Washing machines often incorporate balance rings filled with a liquid such as a calcium chloride salt water solution,[132] that are designed to balance the inner drum of the washer during spin cycles.[133][134] The balance ring may be filled with oil and contain balls on races, somewhat similarly to a ball bearing, to achieve the same effect.[135][136] The Bendix Economat used a flexible rubber inner tub that would squeeze the clothes towards the agitator located in the center of the inner tub in order to remove water from the clothes, instead of spinning the inner tub. This was performed by exerting a vacuum on the inner tub.[137][138] Many home washing machines use a plastic, rather than metal, outer shell to contain the wash water; residue can build up on the plastic tub over time. Some manufacturers advise users to perform a regular maintenance or "freshening" wash to clean the inside of the washing machine of any mold, bacteria, encrusted detergent, and unspecified dirt more effectively than with a normal wash.[citation needed] A maintenance wash is performed without any laundry, on the hottest wash program,[139] adding substances such as white vinegar, 100 grams of citric acid, a detergent with bleaching properties, or a proprietary washing machine cleaner. The first injection of water goes into the sump[140] so the machine can be allowed to fill for about 30 seconds before adding cleaning substances. Flexible rubber hoses are typically used to connect from a building water supply to a washing machine. These hoses are often exposed to full water pressure on a continuing basis and can deteriorate over time, developing bulges or weak spots that eventually cause leaks or catastrophic bursting and flooding. Since the hoses are often hidden from view, they may be difficult to inspect and easily forgotten until a problem occurs. If a hose burst occurs when nobody is present to notice the problem, a huge volume of water can be delivered over a short time, causing extensive interior flooding damage or even structural damage. It has been estimated that a burst supply hose can deliver two tons of water in an hour.[141] To reduce these risks, it is a common recommendation to use flexible hoses which have been jacketed with a braided stainless steel mesh. This jacketing cannot prevent leaks from developing, but it can slow the development of large bulges or "aneurysms" which can burst suddenly without warning. However, even braided metal jackets often cannot withstand the enormous pressures generated by water freezing within an enclosed volume. An additional precaution is to install a washing machine inside a shallow metal or plastic pan, which can collect minor leakage and divert the water to a nearby drain, or to the outside of a building. Drain pans can also divert water released by other problems, such as a jammed solenoid valve in a washing machine. A serious limitation of drain pans is that they typically cannot handle the large volumes of pressurized water released by a burst supply hose, so a drain pan is no substitute for hose burst precautions. In the absence of a drain, a pan may still be useful to confine leakage temporarily, while a local or remote water alarm is triggered. In addition or instead of an alarm, a water detector may signal the main water shutoff valve to the building to be automatically closed to prevent flooding.[142] A very effective precaution is to install a shutoff or isolation valve which stops any water from being supplied, except when a washing machine is actually operating. The simplest method is to manually open and close the hot and cold water shutoff valves (traditionally globe valves) behind the washing machine, each time it is used. This method relies on the washing machine user conscientiously operating the two valves each time laundry is done, in spite of the awkward location of the valves and the tedious process of turning the handles through multiple rotations. An improvement over the traditional setup is to install a specialized laundry shutoff valve.[143] Typically, it consists of two ball valves connected to a single handle, so they can be operated by a horizontal or vertical lever moved by 90 degrees. This makes the operation of the valves a quick procedure, but the washing machine user must still remember to turn off the water, even though the failure to do this produces no immediately obvious problems. To close this risk exposure, some shutoff valves have a spring-energized mechanical timer which is started when the user pushes a lever to open the valves. After a preset time of several hours elapses, the spring-powered mechanism automatically closes the valve without further user intervention.[141] A variant of this setup requires the user to press a button to open the valves for an electrically-timed interval. Other automatic valve operating mechanisms electronically detect when a washing machine draws electrical power as it starts, and then open the water supply valves. Typically, the power plug for the washing machine is connected to a special detector receptacle or cable, to allowing monitoring of the power draw.[143] Although pressurized water supply leaks can cause the most damage in the least amount of time, water drainage can also cause problems if not handled properly. Washing machine drainage hoses should be secured properly to prevent accidental dislodgement, and drains should be inspected and cleared periodically to prevent buildup of laundry lint, mold, and other deposits.[144] Capacity and cost are both considerations when purchasing a washing machine. All else being equal, a machine of higher capacity will cost more to buy, but will be more convenient if large amounts of laundry must be cleaned. Fewer runs of a machine of larger capacity may have lower running costs and better energy and water efficiency than frequent use of a smaller machine, particularly for large families. However, running a large machine with small loads is typically inefficient and wasteful, unless the machine has been designed to handle such situations. For many years energy and water efficiency were not regulated, and little attention was paid to them. From the last part of the 20th century, increasing attention was paid to efficiency, with regulations enforcing some standards. Efficiency became a selling point, both to save on running costs and to reduce carbon dioxide emissions associated with energy generation, and waste of water. As energy and water efficiency became regulated, they became a selling point for buyers; however, the effectiveness of rinsing was not specified, and it did not directly attract the attention of buyers. Therefore, manufacturers tended to reduce the degree of rinsing after washing, saving water and electrical energy. This had the side-effect of leaving more detergent residue in clothes, which can affect people with allergies or sensitivity.[129] In response to complaints, some manufacturers have now designed their machines with a user-selectable option for additional rinsing. The EU requires that washing machines carry an efficiency label. Washing machines display an EU Energy Label with grades for energy efficiency, washing performance, and spin efficiency. Grades for energy efficiency run from A+++ to D (best to worst), providing a simple method for judging running costs. Washing performance and spin efficiency are graded in the range A to G. However, all machines for sale must have washing performance A, so that manufacturers cannot compromise washing performance in order to improve the energy efficiency. This labeling has had the desired effect of driving customers toward more efficient washing machines and away from less efficient ones. According to regulations, each washing machine is equipped with a wastewater filter. This ensures that no hazardous chemical substances are disposed of improperly through the sewage system; on the other hand, it also ensures that if there is backflow in the plumbing system, sewage cannot enter the washing machine.[9] Top-loading and front-loading clothes washers are covered by a single national standard regulating energy consumption.[145] The old federal standards applicable before January 2011 did not restrict water consumption; there was no limit on how much unheated rinse water could be used.[146] Energy consumption for clothes washers is quantified using the energy factor. After new mandatory federal standards were introduced, many US washers were manufactured to be more energy- and water-efficient than required by the federal standard, or even than required by the more-stringent Energy Star standard.[147] Manufacturers were further motivated to exceed mandatory standards by a program of direct-to-manufacturer tax credits.[148] In North America, the Energy Star program compares and lists energy-efficient clothes washers. Certified Energy Star units can be compared by their Modified Energy Factor (MEF) and Water Factor (WF) coefficients. The MEF figure of merit states how many cubic feet (about 28.3 liters) of clothes are washed per kWh (kilowatt hour). The coefficient is influenced by factors including the configuration of the washer (top-loading, front-loading), its spin speed, and the temperatures and the amount of water used in the rinse and wash cycles. Energy Star residential clothes washers must have an MEF of at least 2.0 (the higher the better); the best machines may reach 3.5. Energy Star washers must also have a WF of less than 6.0 (the lower the better).[149] This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. (October 2020) (Learn how and when to remove this message) Commercial washing machines and dryers (at left) in a self-service laundry (Paris, France) Commercial washing machines in a self-service laundromat (Toronto, Canada) A commercial washing machine is intended for more intensive use than a consumer washing machine.[150] Durability and functionality is more important than style; most commercial washers are bulky and heavy, often with more expensive stainless steel construction to minimize corrosion in a constantly-moist environment. They are built with large easy-to-open service covers, and washers are designed not to require access from the underside for service. Commercial washers are often installed in long rows, with a wide access passageway behind all the machines to allow maintenance without moving the heavy machinery. Many commercial washers are built for use by the general public, and are installed in publicly accessible laundromats or laundrettes. Originally, they were operated by coins (similar to older vending machines), but today they are activated by money accepting devices or card readers. The features of a commercial laundromat washer are usually more limited than those of a consumer washer, usually offering just two or three basic wash programs and an option to choose wash cycle temperatures. Some more-advanced models allow extra-cost options such as an additional wash or rinse cycle, at the choice of the user. The typical front-loading commercial washing machine also differs from consumer models in its discharge of spent wash and rinse water. While the consumer models pump used washer water out, allowing the waste drainage pipe to be located above the floor level, front-loading commercial machines generally use only gravity to expel used water. A drain valve at the bottom rear of the machine opens at the appointed time during the cycle, allowing water to flow out. This requires a special drainage trough equipped with a filter and drain, and routed behind each machine. The trough is usually part of a cement platform built for the purpose of raising the machines to a convenient height, and can be seen behind washers at most laundromats. Most laundromat machines are horizontal-axis front-loading models, because of their lower operating costs (notably, lower consumption of expensive hot water). A 1980s Belgian 90 kg load industrial washer (horizontal axis, front load) By contrast, commercial washers for internal business operations (which are often referred to as "washer/extractor" machines) may include features absent from domestic machines. Many commercial washers offer an option for automatic injection of five or more different chemical types, so that the operator does not have to deal with constantly measuring out soap products and fabric softeners for each load by hand. Instead, a precise metering system draws the detergents and wash additives directly from large liquid-chemical storage barrels, and injects them as needed into the various wash and rinse cycles. Some computer-controlled commercial washers offer the operator detailed control over the various wash and rinse cycles, allowing the operator to program custom washing cycles. Most large-scale industrial washers are horizontal-axis machines, but they may have front-, side-, or top-load doors. Some industrial clothes washers can batch-process up to 800 pounds (360 kg) of textiles at once, and can be used for extremely machine-abusive washing tasks such as stone washing or fabric bleaching and dyeing. An industrial washer can be mounted on heavy-duty shock absorbers and attached to a concrete floor, so that it can extract water from even the most severely out-of-balance and heavy wash loads. Noise and vibration are not as unacceptable as in a domestic machine. The machine may be mounted on hydraulic cylinders, permitting the entire washer to be lifted and tilted so that fabrics can be automatically dumped from the wash drum onto a conveyor belt once the cycle is complete. One special type of continuous-processing washer is known as the tunnel washer. This specialized high-capacity machine does not have a drum where everything being washed undergoes distinct wash and rinse cycles. Instead, the laundry progresses slowly and continuously through a long, large-diameter horizontal-axis rotating tube in the manner of an assembly line, with different processes at different positions.[151] "Woman's Friend" machine (c. 1890) The historically laborious process of washing clothes (a task which often consumed a whole day) was at times described as "women's work". The spread of the washing machine has been seen to be a force behind the improvement of women's position in society. Before the advent of the washing machine, laundry was done first at watercourses, and later in public wash-houses known as lavoirs. Camille Paglia and others argue that the washing machine led to a type of social isolation of women,[152] as a previously communal activity became a solitary one. In 2009 the Italian newspaper L'Osservatore Romano reprinted a Playboy magazine article on International Women's Day arguing that the washing machine had done more for the liberation of women than the contraceptive pill and abortion rights.[153] A study from Université de Montréal, Canada presented a similar point of view, and added refrigerators.[154] The following year, Swedish statistician Hans Rosling suggested that the positive effect the washing machine had on the liberation of women makes it "the greatest invention of the industrial revolution".[155] It has been argued that washing machines are an example of labor-saving technology which does not decrease employment, because households can internalize the gains of the innovation.[156] Historian Frances Finnegan credits the rise of domestic laundry technology in helping to undercut the economic viability of the Magdalene asylums in Ireland (later revealed to be inhumanly abusive prisons for women), by supplanting their laundry businesses and prompting the eventual closure of the institutions as a whole.[157] Irish feminist Mary Frances McDonald has described washing machines as the single most life-changing invention for women.[158] In India, dhobis, a caste group specialized in washing clothes, are slowly adapting to modern technology, but even with access to washing machines, many still handwash garments as well.[159] Since most modern homes are equipped with a washing machine, many Indians have dispensed with the services of the dhobiwallahs.[160] Due to the increasing cost of repairs relative to the price of a washing machine, there has been a major increase in the yearly number of defective washing machines being discarded, to the detriment of the environment. The cost of repair and the expected life of a machine may make the purchase of a new machine seem like the better option.[161] Different washing machine models vary widely in their use of water, detergent, and energy. The energy required for heating is large compared to that used by lighting, electric motors, and electronic devices. Because of their use of hot water, washing machines are among the largest overall consumers of energy in a typical modern home.[citation needed][162] Washing machines worldwide release around 62 million tonnes of carbon dioxide equivalent in a year.[when?] However, modern improvements have been made aiming to lower these emission numbers, and it depends on the user's choice to fully determine their environmental impact.[163][better source needed] Centrifugation Laundry Clothes dryer Combo washer dryer Detergent Drying cabinet Energetic efficiency Home appliance Ironing Laundry detergent Laundry symbols Laundry-folding machine List of home appliances Major appliance Silver Nano Standpipe Thor washing machine L'Increvable

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