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**ANALYZING AND IMPROVING AUTOMATED CARDIOPULMONARY
RESUSCITATION**

by

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An Interactive Qualifying Project

Submitted to the Faculty

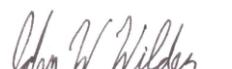
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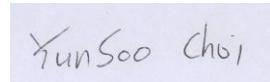
in Aerospace¹ and Mechanical² Engineering



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Abstract

Currently, manual CPR methods do not provide the consistent, effective chest compressions needed to treat a patient. Paramedics often cannot provide the correct force needed and can tire easily while administering CPR. A solution to this issue is to eliminate the human element and utilize the benefits of a mechanized system. By analyzing current CPR methodologies and available automated CPR machines, as well as acquiring feedback from experienced paramedics, we have developed an improved automated CPR machine. Some of the major engineering strengths of current CPR machines are integrated into the improved automated CPR machine. This machine is lightweight and adaptable to be used widely by paramedics. The assembly time of the improved automated CPR machine is significantly enhanced. We believe that this device is a vital aid for paramedics and will undoubtedly be more effective in saving lives than manual CPR.

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Chapter 1. EMS AND LIFE SAVING PRACTICES

1. Introduction

There is no doubt that the emergency procedure known as CPR has given many sudden cardiac arrest victims a second chance at life. According to the American Heart Association, the immediate performance of CPR combined with defibrillation within the first 3-5 minutes after collapse greatly improves the victim's chance of survival (American Heart Association, Inc. [1]). But manual CPR is only effective if the chest compressions are consistent and controlled. Paramedics often cannot provide the correct force needed and can tire easily while administering CPR. With automated CPR, the human element is eliminated, thereby leaving the paramedic free to attend to the patient's other needs and constantly evaluate their condition.

Originally, the idea for this project was to assess the issues surrounding manual CPR and, in the big picture, design a machine that could automatically perform this life-saving procedure. This caught our interest because it was a chance to work on a current problem that has major real-world applications. We gladly accepted the challenge because we knew that the results would involve saving lives.

After doing a little research, our team discovered two CPR devices already whose use is limited around the world. These two CPR machines are called the AutoPulse, from ZOLL Medical Corporation, and LUCAS, from Jolife. The AutoPulse uses a load-distributing technology called the LifeBand, while the LUCAS provides chest compressions via a mechanical arm with a suction cup. Due to this discovery, we realized that our project idea wasn't as original as we thought, and this led to a major change in our original goal for this project.

Instead of reinventing the wheel, we focused on three new dimensions. They were investigating these machines and other topics related to resuscitation, finding out the issues paramedics are experiencing with them, finding solutions to these issues, and producing a device that is stable, reliable, and easy to use. This report will be a detailed account of our engineering process, starting with our background research in Chapter 2, and ending with our final design in Chapter 3. Chapter 4 contains our concluding remarks. In Chapter 2, we present detailed information about CPR, the AutoPulse and LUCAS machines, and the CPR aids, AEDs. This information provided us an opportunity to design an improved CPR machine. Chapter 3 contains the improved CPR design. The conclusion and future work recommendation are contained in Chapter 4.

Chapter 2. EMS AND PATIENT-CENTRIC QUALITY CARE

2. Introduction

The human heart's main role is that of circulating blood throughout the body.

Cardiac arrest occurs when the heart loses its function and stops circulating the blood to the whole body. Common causes of cardiac arrest are smoking, abnormal cholesterol, diabetes, high blood pressure, stress, abdominal obesity, sedentary lifestyle, eating too few fruits and vegetables, and abstaining from alcohol. Many vital organs can be damaged from the lack of blood flow. The brain, more than others, can be severely damaged if the blood is not supplied for a minimum of 4 to 5 minutes. Once the victim has received brain damage, the chances of eventual recovery drop significantly.

Cardiopulmonary Resuscitation (CPR) is the emergency procedure that helps restore the circulation of blood after a person experiences cardiac arrest. CPR is performed using a combination of rescue breaths and chest compressions. Chest compressions must be applied at a rate of 100 per minute in order to create artificial circulation by manually causing the heart to pump blood through the body. From the statistical research, if the CPR is applied immediately and correctly, this procedure can return life to a person from cardiac arrest 3 times more than without it.

2.1 Cardiopulmonary Resuscitation Processes and Procedures

To properly perform Cardiopulmonary Resuscitation, after assessing the situation to make sure it is safe for the victim to be treated, check to see if the victim is responsive by calling to them and gently shaking them. If they are non-responsive, immediately call for help or designate someone to call 9-1-1. After calling for help, tilt the victim's head back and lift the chin to open their airway. Once the airway is open, pinch the nose closed, take a normal breath, cover the victim's mouth with yours and blow out until you see the chest rise. Then give a second breath. If the chest doesn't rise, open the airway again and repeat the breaths. Next place the heel of one hand in the center of the chest and your other hand on top of it. Press the victim's chest down approximately 2 inches. Perform thirty compressions at a rate of one hundred per minute. Finally, repeat the breaths and compressions until help arrives, or the victim is revived.

2.2 Saving Life by CPR

The American Heart Association gave a list of CPR facts and statistics that show common knowledge about CPR. About 75 percent to 80 percent of all out-of hospital cardiac arrests happen at home. Being trained to perform cardiopulmonary resuscitation (CPR) can mean the difference between life and death for a loved one. Effective bystander CPR, provided immediately after cardiac arrest, can double a victim's chance of survival. CPR helps maintain vital blood flow to the heart and brain and increases the amount of time that an electric shock from a defibrillator can be effective.

Approximately 95 percent of sudden cardiac arrest victims die before reaching the hospital. Death from sudden cardiac arrest is not inevitable. If more people know CPR, more lives can be saved. Brain death starts to occur four to six minutes after someone experiences cardiac arrest if no CPR and defibrillation are administered during that time. If bystander CPR is not provided, a sudden cardiac arrest victim's chances of survival fall 7 percent to 10 percent for every minute of delay until defibrillation. Few attempts at resuscitation are successful if CPR and defibrillation are not provided within minutes of collapse. Coronary heart disease accounts for about 550,000 of the 927,000 adults who die as a result of cardiovascular disease (American Heart Association, Inc. [4]).

Approximately 335,000 of all annual adult coronary heart disease deaths in the U.S. are

due to sudden cardiac arrest, suffered outside the hospital setting and in hospital emergency departments (American Heart Association, Inc. [4]). About 900 Americans die every day due to sudden cardiac arrest (American Heart Association, Inc. [4]). Sudden cardiac arrest is most often caused by an abnormal heart rhythm called ventricular fibrillation (VF). Cardiac arrest can also occur after the onset of a heart attack or as a result of electrocution or near-drowning which results in the victim becoming unresponsive.

2.3 Manual CPR

Today most rescuers often perform CPR manually, but it is very hard to compress the chest using only their arms and hands and achieve success in a timely manner. There are three factors that are needed to perform successful CPR. The chest compression should be given quickly, forcefully, and consistently. As the time passes after the cardiac arrest, effective CPR process becomes increasingly more important. Sometimes effective CPR determines whether or not the patient will live. Therefore CPR must be applied as soon as possible after the rescuer arrives at the victim. If CPR is applied as little as five minutes after the patient suffered sudden cardiac arrest, there is a greater potential that the patient will not recover. The CPR process must be applied as soon as possible. No matter how the rescuer performs CPR, the patient will have a better chance to live if the process is applied quickly. This is why the quickness of CPR is important. The second factor of good chest compression is force. To achieve the perfect compression, the average compressive force must be equivalent to 490.5 Newtons (Medtronic [18]). This

force must be consistent through the entire action when CPR is being performed. However, manual CPR has its limitation in that the quality of the compression will be lower as time elapses. The quality of manual chest compression chart is shown in Figure 2.3.

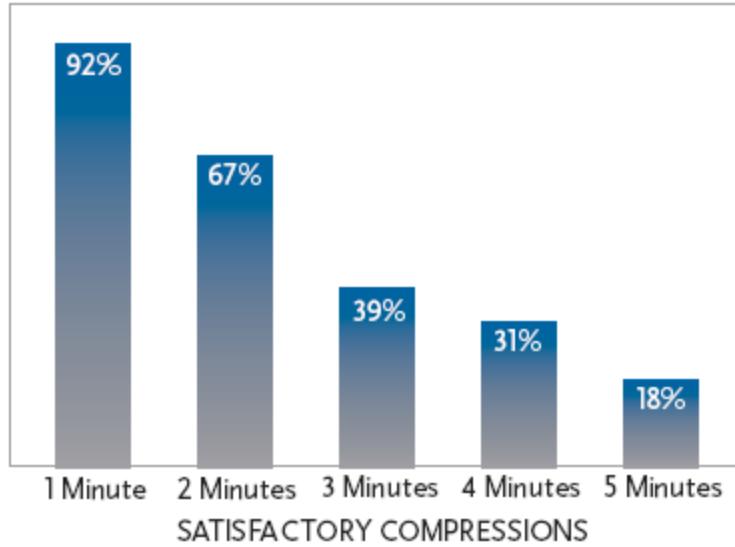


Figure 2.3 Quality of compressions during CPR.

Figure 2.3 illustrates the declining quality of compressions during CPR over a period of 5 minutes. As shown, manual CPR begins to lose its quality after 1 minute and after 4 minutes, the rescuer only achieves 30% of proper quality chest compressions (Medtronic [18]). This means the effectiveness of CPR is lower and not enough force is delivered to the heart. Therefore, good and consistent force of chest compressions should be applied during the CPR process.

The last factor of good quality CPR is consistency. Losing consistency means stopping the flow of blood and after sometime the patient's organs suffer from lack of

oxygen. This means if there is any interruption in the CPR process, the patient's survival rate will greatly decrease. However, it is very difficult to deliver consistent chest pressure in a moving ambulance. Sometimes automated CPR or a defibrillator is required to solve this problem. By combining this with the other factors, the perfect chest compression can be performed and the patient's survival rate will be increased.

2.3.1 Manual CPR Survival

Cardiopulmonary Resuscitation is the best emergency procedure to restore circulation from cardiac arrest, but there are some issues that have arose. One of the major issues is concerning the chest compressions. Different performers of CPR will give different compression depths and rhythms. There is no way to standardize the performance while manually performing CPR. A major cause of the inconsistency is fatigue; humans are susceptible to fatigue especially when it is considered that a full session of CPR can consist of a dozen or more repetitions of thirty chest compressions and two rescue breaths. The survival rate of CPR for outside of hospital is less than 5% these days. From Swedish National Register, the chart of the survival rate is given below.

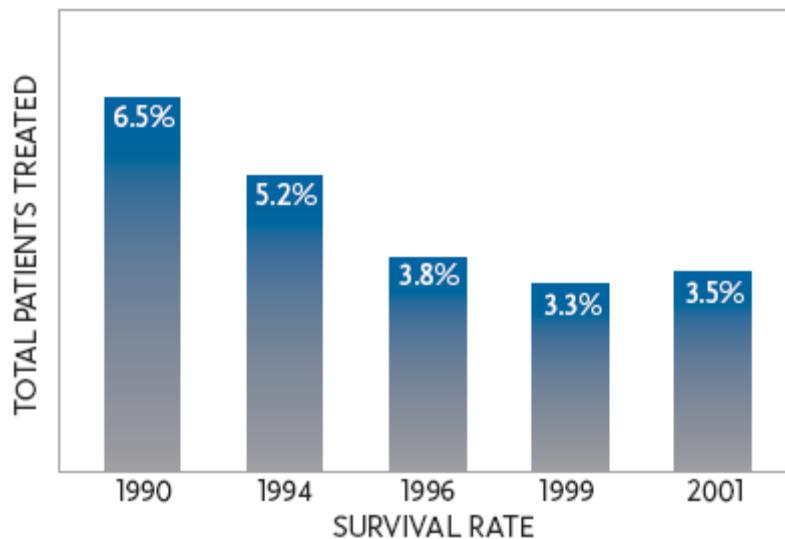


Figure 2.3.1 Survival rate of sudden cardiac arrest victims

Figure 2.3.1 illustrates the survival rate of sudden cardiac arrest victims in certain years (Medtronic [18]). From the chart, one can note many people can survive from sudden cardiac arrest. This fact must be considered, so more patients get their life back.

2.3.2 Common Side Effect of CPR

It is very easy to break a victim's ribs during CPR. About 30 percent of cardiac arrest patient had cracked the ribs after they got CPR. It happens more often to older people because the cartilage is less compliant and the bone is easier to break. Even though breaking ribs cause bad effect to patient such as chest tenderness, rapid breathing, anxiety and agitation. However EMS and all other CPR performer do crack ribs if necessary, because the broken ribs will be healed their own after one or two months and it is believed that it is always better to have cracked ribs than to let the patient expire (Center for Women's Health Care [3]).

2.4 Mechanized CPR

2.4.1 LUCAS CPR

Providing compressions on the chest to simulate the heart's function which pumps rhythmically is the reason of CPR when the victim suffers cardiac arrest. Many

manufacturers have made mechanical devices that perform CPR more effectively than one human effort. Chest compression devices should appear very attractive to anyone who performs CPR. Among those devices, LUCAS CPR is the one which is currently used in the field. Our team decided to benchmark LUCAS CPR version 2.0 to create a new hands-off automated CPR device. LUCAS CPR makes compressions with correct frequency and depth, with equal compression and decompression time, and allowing for full recoil of the chest between each compression without loss of quality over time. This device can perform effective, consistent and uninterrupted compressions according to AHA Guidelines (American Heart Association Guidelines). To increase its effectiveness, Jolife made the device easy to use and easy to carry (Physio-Control [17]). For the energy source, LUCAS CPR has been upgraded to version 2.0, so the energy source changed to electric from pneumatic, and the device became more portable.

2.4.1.1 Technical Specifications

The LUCAS provides effective sternal compressions on the middle of the chest of a depth of 4 – 5 centimeters at a rate of 100 strokes per minute. The time of compression is equally balanced with the time of decompression allowing for full chest recoil between each compression. The device is designed to accommodate victims with a sternum height of 17.0 – 30.0 centimeters and a maximum chest width of 44.9 centimeters. Physically, the machine weighs 7.8 kilograms. The energy source to power the device comes from a Lithium Polymer Battery which provides a steady operation time of 45 minutes before the battery needs to be replaced. LUCAS version 1.0 is based on gas driven cycle, but

main energy source has been changed to fully electric system from version 2.0. The device operates with lithium polymer battery. This battery is different than NiCad or NiMH batteries do when charging and discharging. These batteries have a nominal voltage of 3.6 volts, but they do not have a hard metal case. To enclose the chemicals inside, a flexible material is used. The most advantage of using Lithium Polymer batteries is the weight. They are significantly lighter than comparable other batteries. Lithium Polymer batteries need to be taken care from temperature. The batteries cannot placed where is too hot or cold (Jolife AB [11]).

2.4.1.2 Components and Accessories

Many contents and accessories are included in one package. All the details are shown on the next page.



LUCAS™2 Chest Compression System

This includes the base unit with Back Plate, Carrying Bag, Patient Straps, Stabilization Strap, three Suction Cups, one rechargeable lithium polymer Battery, and Instructions for Use in local language.

LUCAS 2 in shipping box, US	JOLIFE Part No. 150000-00
LUCAS 2 in shipping box, GB, FR, IT, DE, NL	150000-01
LUCAS 2 in shipping box, DK, SE, FI, NO	150000-02
LUCAS 2 in shipping box, ES, PT, GR	150000-03
LUCAS 2 in shipping box, PL, CZ, HU	150000-04
LUCAS 2 in shipping box, JP	150000-05



LUCAS™2 Battery

The Battery is a proprietary and rechargeable Lithium Polymer (LiPo) Battery which typically lasts for 45 minutes of operation. You can charge the Battery in less than four hours either in the external Battery Charger or installed in LUCAS and connected to an external Power Supply.

LUCAS 2 Battery	JOLIFE Part No. 150201-00
LUCAS 2 Battery, 4-pack	150201-04



LUCAS™2 Battery Charger

The external Battery Charger is a stand-alone unit intended to charge one LUCAS 2 Battery. It typically takes less than 4 hours to charge the Battery. A mounting bracket is included for space saving installation.

LUCAS 2 Battery Charger, US, CA, JP, mains plug	JOLIFE Part No. 150207-00
LUCAS 2 Battery Charger, EU, mains plug	150207-01
LUCAS 2 Battery Charger, GB, mains plug	150207-02
LUCAS 2 Battery Charger, AU, mains plug	150207-03



LUCAS™2 Power Supply with cord

The External Power Supply (100-240VAC, 50/60Hz) can be connected to the LUCAS 2 device and supports prolonged operation as well as charging of the LUCAS 2 Battery in the device.

LUCAS 2 Power Supply with cord, US	JOLIFE Part No. 150210-00
LUCAS 2 Power Supply with cord, EU	150210-01
LUCAS 2 Power Supply with cord, GB	150210-02
LUCAS 2 Power Supply with cord, JP	150210-03
LUCAS 2 Power Supply with cord, AU	150210-04



LUCAS™2 Car Cable

The Car Cable (12-24V DC) can be connected to the LUCAS 2 device and supports prolonged operation as well as charging of the LUCAS 2 Battery in the device.

LUCAS 2 Car Cable	JOLIFE Part No. 150206-00
-------------------	------------------------------

Figure 2.4.1.2-1 LUCAS components and accessories



LUCAS™2 Suction Cup

LUCAS 2 has a disposable Suction Cup which can be easily exchanged.

JOLIFE Part No.

150205-03

150205-12



LUCAS™ PCI Back Plate

The carbon-fibre LUCAS PCI Back Plate is intended specifically for use in the cath lab. It is fully radiotranslucent, with minimum of shadows, and no metal screws.

JOLIFE Part No.

150211-00



LUCAS™ Back Plate Grip Tape

The LUCAS Back Plate Grip Tape is designed to increase the friction of the Back Plate and to reduce the risk of the device slipping when the Back Plate is in contact with other hard surfaces.

JOLIFE Part No.

150209-00

150209-03



LUCAS™ Stabilization Strap

The cushion and straps are used to provide further stabilization relative to the patient and to prevent downward movement of LUCAS during operation.

JOLIFE Part No.

150203-00

150203-05



LUCAS™ Patient Straps

The LUCAS Patient Straps (two required per device) are used to attach patient arms to the support legs of LUCAS during transportation.

JOLIFE Part No.

150204-00

150204-03



LUCAS™2 Carrying Bag

LUCAS 2 is stored and carried in a padded Carrying Bag.

JOLIFE Part No.

150200-00

Figure 2.4.1.2-1 (continued) LUCAS components and accessories

With these contents, the real view of LUCAS CPR version 2.0 is shown below.

The device looks very simply and portable compare to other automated CPR or defibrillator.



Figure 2.4.1.2-2 LUCAS system

Figure 2.4.1.2-2 displays an image of the LUCAS device.

2.4.1.3 Statistics of Manual VS LUCAS CPR

To know more about the efficiency of LUCAS CPR, a logical approach would be to make a comparison between manual and mechanical chest compression. From the reference, two cases of settings had been compared. The first setting is that a team of three experienced resuscitators administrated continuous manual chest compressions for 10 minutes, changing every minute (after approximately 100 compressions). The second setting is that a team of two resuscitators started manual CPR and installed a LUCAS CPR device to perform CPR for 10 minutes. The performance comparison between manual and mechanical CPR was founded. They divided into two groups to perform CPR and resuscitator characteristics of two teams were shown in the table below.

Table 1
Resuscitator characteristics.

	Gender	Age (years)	Weight (kg)	Height (m)	BMI (kg/m ²)	Qualification	Professional experience (years)
Team 1							
C.R.	m	26.0	82.0	1.82	24.8	dipl. RS	8.0
M.G.	m	33.0	84.0	1.92	22.8	dipl. RS	14.0
I.M.	f	32.0	64.0	1.72	21.6	dipl. RS	8.0
mean		30.3	76.7	1.82	23.1		10.0
Team 2							
S.J.	m	36.0	73.0	1.82	22.0	dipl. RS	10.0
A.H.	m	32.0	93.0	1.81	28.4	dipl. RS	11.0
C.W.	m	34.0	68.0	1.78	21.5	Dr. med., ACLS Instructor	10.0
mean		34.0	78.0	1.80	24.0		10.3
All							
mean		32.2	77.3	1.81	23.5		10.2
(dipl. RS = graduated paramedic, ACLS = Advanced Cardiac Life Support)							

Table 2.4.1.3-1 Resuscitator characteristics

Table 2.4.1.3-1 shows the characteristics of the CPR providers involved in the experiment. Team 1 is consisted of 2 males and 1 female, and team 2 is consisted of 3

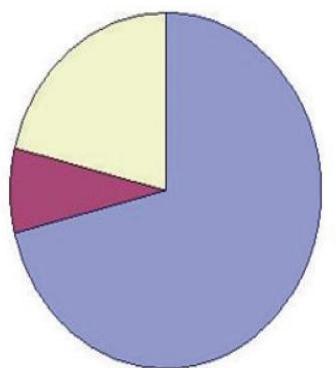
males. The average of weight, height, and experienced time were about the same between 2 teams, but the average age of team 2 was four years higher than team 1. The result of the CPR performance of 2 teams and LUCAS CPR version 2.0 are shown in the table below. The table shows how many sequence were performed, the number of hands-off(s), the number of given compression, the percentage of correct compression, too deep, and too shallow, and finally shows the compression rate per minute.

Table 2
CPR performance.

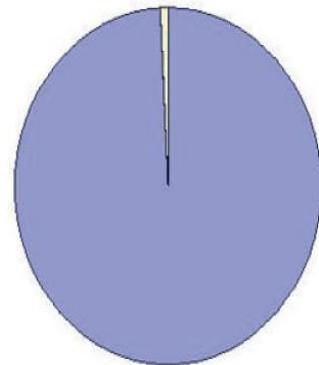
Sequence	Manual CPR						Mechanical CPR				
	Team 1	Team 2	Team 1	Team 2	Team 1	Team 2	LUCAS™2	Device failure!	LUCAS™1	10	11
Hands-off (s)	12	8	8	8	8	8	11	10	45	9	10
Compressions	1206	1217	1131	963	888	918	990	1005	912	1023	1027
Correct compressions (%)	54	76	91	54	77	67	99	97	84	99	98
Too deep (%)	44	0	2	0	0	1	0	0	0	0	0
Too shallow (%)	0	22	5	45	21	31	0	2	15	0	1
Compression rate (per min)	120	121	112	96	88	91	99	100	100	102	102

Table 2.4.1.3-2 CPR Performance

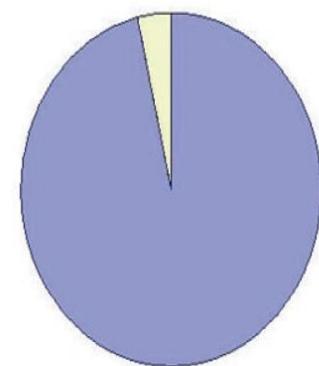
According to the data, six sequences were performed and each sequence performed over 10 minutes. Whole six sequences provided total of 6323 compressions for manual CPR. This result shows the average compression of 105/min which is in range of recommendation, but there was different number of compressions for each sequence from 88/min to 121/min and only 70% of chest compression is analyzed as correct. For the result of LUCAS CPR, total 3 sequences were performed and total 4957 compressions were provided. This result was satisfied with recommendation and also the range of number of compressions was very narrow from 99/min to 102/min. 98% of all compressions were classified as correct and there was no deep compression analyzed. Graphs of each analysis are show on the next page.



Manual CPR



Mechanical CPR
(no device failure)



Mechanical CPR
(device failure)

Figure 2.4.1.3-3 Graphical results of the above experiment

From the analysis in Figure 2.4.1.3-3, manual CPR resulted in ‘too deep’ compression in 8% and 21% of too ‘shallow’ compressions were occurred. Nevertheless LUCAS CPR made a result of 0% ‘too deep’ compression and only 0~2% of ‘too shallow’ compression. Not only the proportion of correct compression depth was much better during performance of LUCAS CPR but also with device failure mechanical CPR performed better (95% VS 70%). Finally, the research concluded that mechanical CPR devices may have advantages over manual CPR, if the device is not showing any mechanical failure.

2.4.2 AutoPulse Non-Invasive Cardiac Support Pump

When we performed our initial internet search on "automated CPR machines" back in the beginning of A term, one of the top results led us to an ABC News article about a high-tech device called the Autopulse. The article went on to describe some of its praiseworthy features including its reasonable 20 pound weight, 80 chest compressions per minute capability, and respectable battery life (Eng [8]). Due to this new discovery, we figured it would be more logical to address the device's flaws and improve its function, rather than, as the expression goes, reinvent the wheel. But first, we needed to learn a lot more about this revolutionary device.

The full name of this device is the AutoPulse Non-Invasive Cardiac Support Pump. It was created by the Revivant Corporation of Sunnyvale, CA but is currently owned and manufactured by the ZOLL Company of Chemsford, MA. It claims to move

more blood, more consistently than is possible with human hands (ZOLL Medical Corporation [21]).

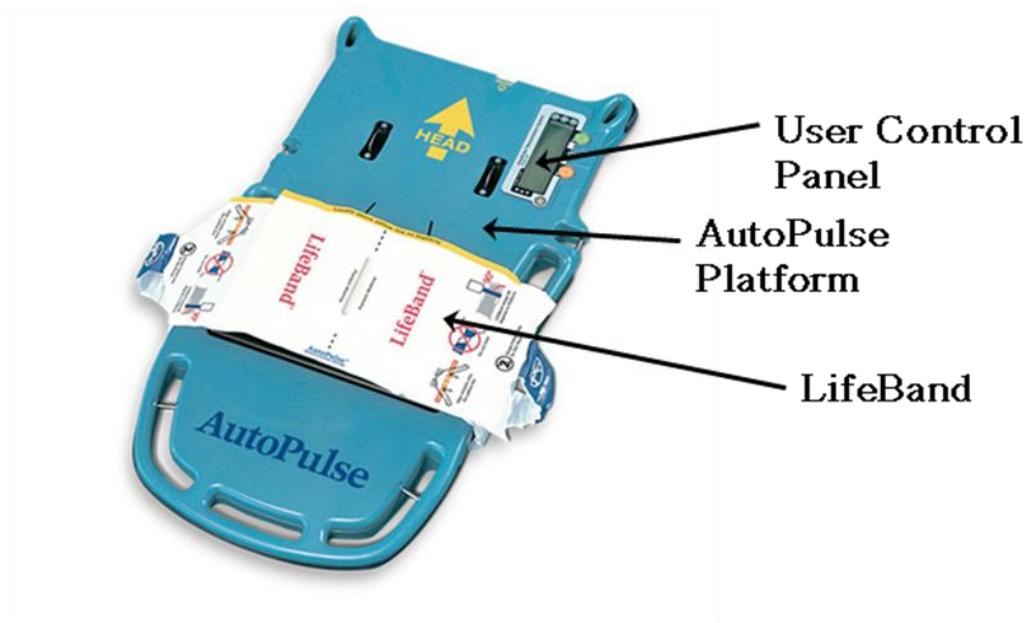


Figure 2.4.2 AutoPulse

Figure 2.4.2 shows a picture of the AutoPulse device. It consists of a half-backboard, user control panel, and a constricting band called the LifeBand. It runs on a nickel-metal hydride battery that has a minimum run time of 30 minutes. For patient, operating, physical and battery parameters, see Appendix A. The highlight of the device is the white LifeBand that gives continuous, consistent, high-quality compressions that spread across the victim's entire chest, thus distributing the load and lowering the chance of rib fracture. An impressive feature of this device is its ability to "automatically determine the size, shape, and resistance of each individual, then adjusting the force required (Zoll Medical Corporation [21])." Operating the AutoPulse is as easy as placing the patient on the platform, securing the LifeBand across their chest, powering on the

system, and pressing a couple buttons on the control panel. With the AutoPulse, paramedics are now free to perform other critical tasks necessary to save the victim's life. According to an ABC News article, the machine has been approved by the Food and Drug Administration and costs around \$15,000 (McKenzie [16]). Approximately 2000 units are in use by EMS agencies and hospitals globally (ZOLL Medical Corporation [26]).

2.4.2.1 Clinical Studies

Many of these seemingly self-proclaiming facts about the AutoPulse can be supported by clinical studies done on the device. Between 2001 and 2005, a long-term survival study was done by Virginia Commonwealth University to compare the resuscitation outcomes before and after EMS services switched from manual CPR to the AutoPulse (JAMA [10]). The study was published in The Journal of the American Medical Association in 2006. The statistics collected were return of spontaneous circulation (ROSC), survival to hospital admission, and survival to hospital discharge.

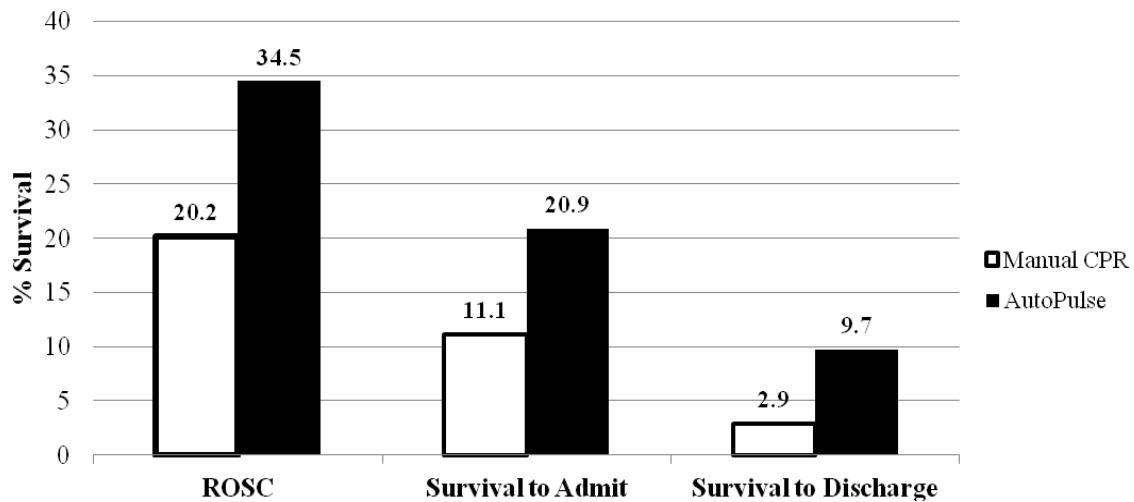


Figure 2.4.2.1-1 Virginia Commonwealth University long-term survival study

Figure 2.4.2.1 shows the results of the long-term study comparing manual CPR to AutoPulse. As you can see, the AutoPulse is clearly the better choice for resuscitation method.

Two short term clinical studies were also conducted that looked at the survival rate of patients with sustained ROSC to the Emergency Department (ED). One study was done by the San Francisco Fire Department and the other by EVAC Ambulance in Volusia County, Florida.

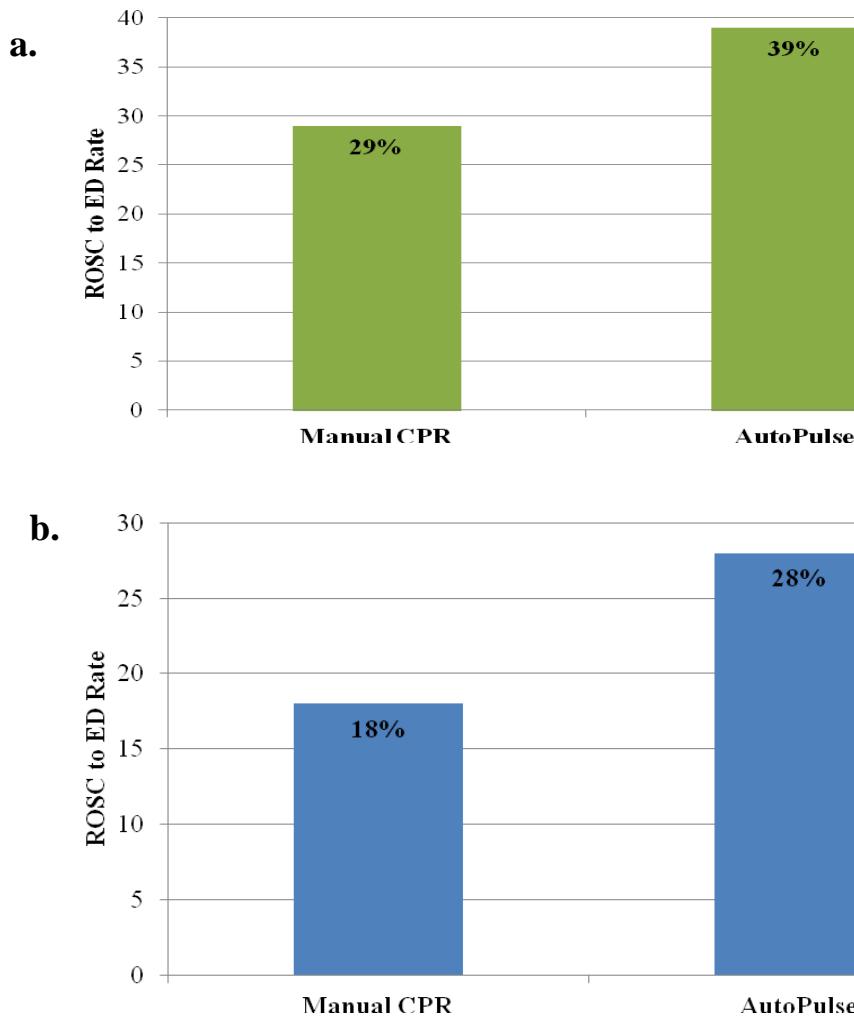


Figure 2.4.2.1-2 a. San Francisco Fire Department study
 b. EVAC Ambulance study

Figure 2.4.2.1-2 a. above displays the results from the San Francisco Fire Department study comparing manual CPR to the AutoPulse. Figure 2.4.2.1-2 b. displays the results from the EVAC Ambulance study comparing the same CPR methods, manual versus mechanical. Again, the AutoPulse proved to be the more successful life-saving method.

In 2007, a third study was set up to test the effectiveness of an AutoPulse-manual chest compression combination method in comparison to manual chest compressions alone. This official study is called the CIRC Trial.

2.4.2.2 The CIRC Trial

Unlike the two studies mentioned above, the CIRC Trial is a more controlled and specialized experiment. CIRC stands for Circulation Improving Resuscitation Care. The study is monitored by the Data Safety Monitoring Board (DSMB), and is lead by the world-renowned CPR expert Dr. Lars Wik of Norway. The sample size is expected to be between 2,500 and 4,000 and will include patients from all around the world. The individuals administering the AutoPulse and manual CPR are put through an extensive four-hour training program that explains the proper use of the AutoPulse. The study complies with the Good Clinical Practices, Declaration of Helsinki, and other national and international guidelines (ZOLL Medical Corporation [25]).

An online article about the CIRC Trial was featured in Cardiovascular Business.

According to the article, the trial has six "unique" features (Editorial Staff [7]):

- Training of all EMS providers in a standardized deployment strategy that reduces hands-off time and continuous monitoring for protocol compliance.
- A pre-trial simulation study of provider compliance with the trial protocol.
- Three distinct study phases (in-field training, run-in and statistical inclusion) to minimize the Hawthorne effect and other biases.
- Monitoring of the CPR process using either transthoracic impedance or accelerometer data.
- Randomization at the subject level after the decision to resuscitate is made to reduce selection bias.
- Use of the Group Sequential Double Triangular Test with sufficient power to determine superiority, inferiority or equivalence.

The official CIRC Trial website also gives some interesting facts and findings (ZOLL Medical Corporation [24]):

- Each year, 325,000 Americans die from cardiac arrest and only 2-5% are successfully resuscitated and survive to hospital discharge.
- Studies have shown that manual chest compressions are often inadequate, not providing sufficient blood flow needed by the heart and brain during a sudden cardiac arrest. This can result in permanent damage to the heart, brain, and other organs in those who survive.

- It is nearly impossible to give optimal compressions to a victim during transport via stairs or in a moving ambulance.
- Even professional healthcare providers who are trained to do proper compressions will experience fatigue within minutes, resulting in lower quality compressions.

The people behind the CIRC Trial believe that mechanical CPR can overcome most of these issues.

In a 2009 ZOLL news release, it was announced that the first planned review of data related to patient enrollment by the DSMB has been completed and that the study will continue (ZOLL Medical Corporation [23]). Then, on March 31, 2011, news came in regarding the outcome of the CIRC Trial. It was concluded that the AutoPulse was equivalent to manual chest compressions (Editorial Board [6]).

Before this very recent discovery regarding the CIRC Trial results, one could clearly see that the AutoPulse is a great piece of equipment. But to really find out how beneficial this device can be to paramedics, we decided that we needed to ask the paramedics themselves.

2.5 CPR Aids

2.5.1 Automatic External Defibrillator

An Automatic External Defibrillator (AED) is a small, portable device that analyzes the heart's rhythm and prompts the user to deliver a defibrillation shock if it determines one is needed. The AED is equipped with a system that provides voice and visual prompts which guide the user. The AED uses disposable, adhesive electrodes pads which transport information to the AED's microprocessor which analyzes the victim's heart rhythm. If needed, the AED delivers an electronic shock which briefly stops all electrical activity in the heart. This break in the electrical chaos provides a chance for the heart to restart beating with a normal rhythm. This device has been shown to be 90% sensitive and 99% specific. It has also been shown that for every minute defibrillation is delayed; survival rates drop by 7-10 percent even if CPR is started immediately. This is relevant when considering that the average time it takes an emergency crew to arrive is between 6-12 minutes (Hubbard Township Police [9]).



Figure 2.5.1 Automatic External Defibrillator

Figure 2.5.1 shows a picture of an AED, complete with defibrillator pads and heart monitor.

2.5.2 Q-CPR Measurement and Feedback Tool

Another great tool that aids in CPR performance is a device called Q-CPR Measurement and Feedback Tool from Philips. This tool shows all the measurable information of every CPR compression, so factors like depth, rate and “complete release” can be shown on the product’s screen, which is located directly at the victim’s chest level (Koninklijke Philips Electronics [7]). This dynamic, real-time feedback for each compression enables the CPR performer to rapidly adjust performance, ensuring that maximum quality CPR is given. This tool is also very portable and easy to carry.



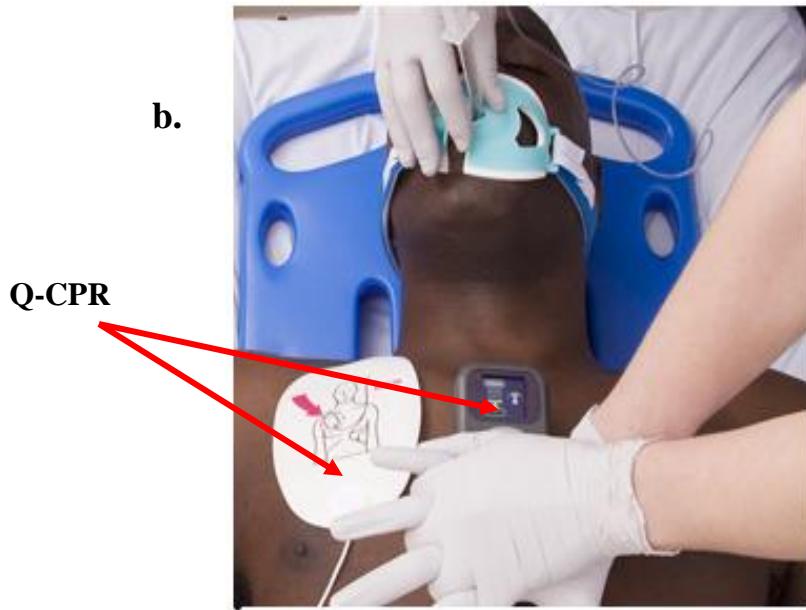


Figure 2.5.2 a. Q-CPR Measurement and Feedback Tool
b. Q-CPR used with a patient

Figure 2.5.2 a. shows the complete Q-CPR system. It contains two compression sensors, a visual feedback component, and a vital signs monitor. Figure 2.6.2 b. shows the Q-CPR in action. As you can see, the visual feedback piece is conveniently located at the chest level.

Clearly, this tool could help more for manual CPR because manual CPR gives more unstable compressions than automated CPR. However, the benefits that Q-CPR gives to manual compressions could also be used in the current LUCAS CPR machine. As an experiment, Q-CPR could monitor those compression factors of the LUCAS like depth, rate, and “complete releases” and provide data to the Jolife Company. This data could then be analyzed to find out the quality of compressions the LUCAS gives. If such

a test were conducted, and the scientists decided on the acceptable values for compression depth and rate, then a possible enhancement to the LUCAS machine would involve an integration with the Q-CPR, and the LUCAS automatically readjusting its compression if the depth and rate factors read by the Q-CPR fall below the safety value.

There is one more great function in Q-CPR, which is hyperventilation protection. Hyperventilation decreases coronary perfusion and it would be very helpful if the information of hyperventilation was shown during the CPR (Koninklijke Philips Electronics [12]). The unique technology of Q-CPR can provide this ventilation feedback. This and all the features mentioned above make the Q-CPR a highly beneficial CPR aid.

Chapter 3. Improved Automated CPR Machine

3. Introduction

3.1 Original Design

The original idea for this device was to integrate an automatic external defibrillator into an existing automated CPR machine. The Autopulse device was chosen because of its ability to distribute the pressure over the chest; the assumption being that this would reduce the amount of broken ribs as a result of CPR. The idea behind integrating the AED was that the computer system in an AED could run the entire device to decide when to perform CPR and when to deliver a shock to the patient.

3.2 Interview with UMASS Memorial EMS Paramedics

Once we had obtained all of our background research and became more knowledgeable in the field of resuscitation, the next important aspect of our project was to acquire some first-hand information about CPR and the devices related to it. Through Professor Fofana's connections at UMASS Memorial, we were fortunate enough to have an opportunity to speak with the Chief of EMS, Mr. Steve Haynes.

We had prepared a list of questions we hoped to ask Mr. Haynes, most of them being about the AutoPulse. See Appendix B for our list of interview questions. Most of the questions did not end up being asked, simply because Mr. Haynes had answered them in his opening statement. After discovering that we wanted to talk to him about the AutoPulse, Mr. Haynes gave us his opinion right away.

"It's no good!" exclaimed Mr. Haynes. This gave us quite a shock, for our research had told us otherwise. But that was the purpose of the interview. We needed to know what the users, the paramedics, thought of the product. Mr. Haynes more specifically stated that the device was too heavy. He explained that the paramedics were already carrying various medical bags and a monitor defibrillator to the scene, so having to carry another heavy load would not be helpful. Another problem he predicted would occur with the AutoPulse was when the AutoPulse was used in combination with the long backboards they use to transport patients. It's clear that there would be some patient instability in this situation due to the fact that two backboards are in contact with each other and the contact friction between them is presumably low. Plus, he mentioned that there weren't even straps on the AutoPulse's half-backboard to anchor the device to their

backboards. So, due to this issue and its poor portability, Mr. Haynes decided that the AutoPulse was not a device his EMS team would be using in field. And unfortunately, that meant we would not be to see the AutoPulse in person like we hoped.



Figure 3.2.1: A metal “scoop” backboard and a standard backboard

There were, though, a couple of benefits Mr. Haynes had praised about the AutoPulse. Many emergency situations involve transporting a patient down a flight of stairs to get them into the ambulance. Paramedics often struggle to provide continuous compression down those steps. Another problem paramedics face is the difficulty in providing chest compressions to a patient in the back of a moving ambulance. Mr. Haynes says they normally can only perform one-handed compressions, for their other

hand is being used to support themselves. He believes that in both those cases, the AutoPulse could overcome those struggles.

After we obtained all the pros and cons of the AutoPulse, we asked him a few other questions related to CPR, the LUCAS, and our AutoPulse-AED integration idea. Regarding CPR, Mr. Haynes told us that it is always performed while the patient is laying down on a flat surface. And in terms of correct positioning for chest compressions, he said that the proper placement was right at the sternum, at the level of the nipple-line. Regarding the LUCAS, he believed that the LUCAS was a better machine than the AutoPulse, due to it being lighter. The only issue he saw with it was that it was powered by air, and they don't carry air tanks in the ambulance. We later find out that, from our visit to the Auburn Fire Department, that the LUCAS had its own portable air compressor. We closed our interview by pitching to him our idea of integrating an AED with the AutoPulse. He told us that it sounded like a beneficial idea, but the problem would be the large number of wires involved in the hook-up. During the resuscitation process, the paramedics must have the monitor defibrillator handy and hook the patient up to an IV. These tubes and wires combined with the AED pads and AutoPulse LifeBand would create and unmanageable mess of wires.

Once we completed the interview and assessed the answers, our next step was to come up with a solution. We quickly formulated a design idea that would involve features from both the AutoPulse and the LUCAS. This design was going to be our focus for the rest of B term.

3.3 Revised Design

After the interview with UMASS Memorial EMS, the original design needed to be completely revamped. As we discovered, the use of defibrillation was not always necessary so integrating an AED would have been an unneeded complication. There was still a desire to use the LifeBand from the AutoPulse to distribute the pressure and combat the breaking of ribs during CPR. The resulting design was a composite design using the LifeBand from the AutoPulse in the frame of the LUCAS.

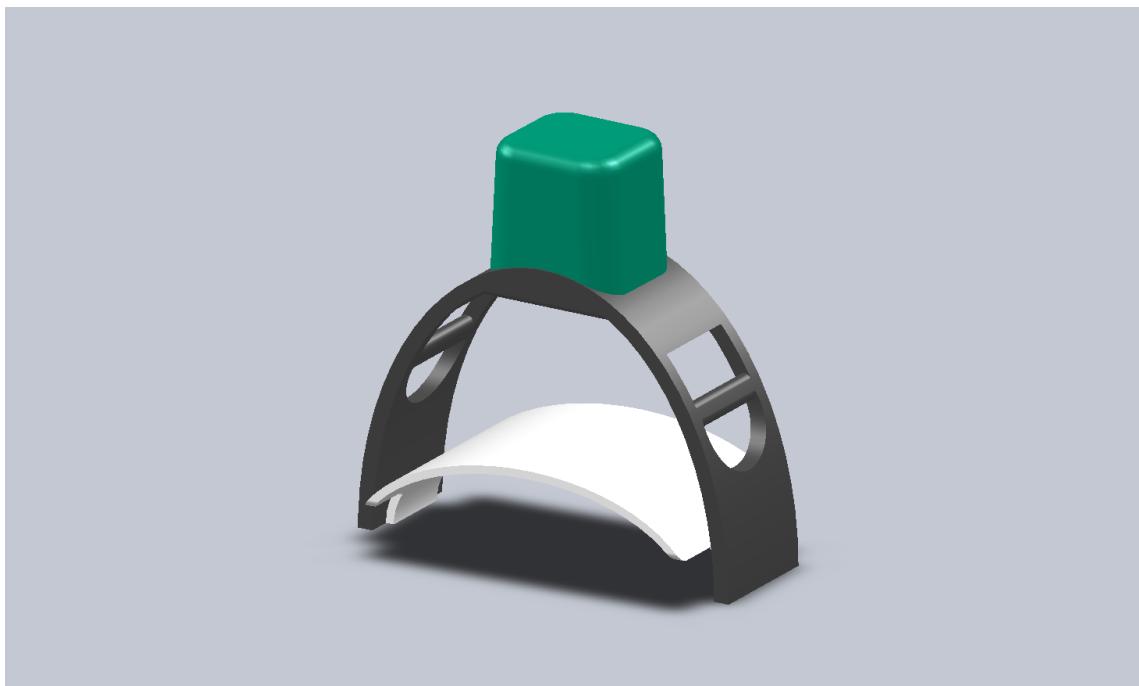


Figure 3.3.1: Computer model of the first design revision

3.4 Interview with Auburn, Massachusetts Fire Department Paramedics

Firefighter/Paramedic Christopher Cavan of the Auburn Fire Department was fully trained on the LUCAS device and agreed to answer some interview questions. He described the LUCAS as portable, easy to deploy, and effective.



Figure 3.4.1: The LUCAS pack

The only factor hindering the rapid deployment was the device's weight. Also, the center of mass, located towards the top of the device, caused the device to be somewhat cumbersome. Sometimes when transporting a patient on a backboard the board must be inclined to move down stairs or in an elevator. An issue that was found from use in the field was that when the board is inclined to an angle greater than 45 degrees, the LUCAS was likely to slip out of position and therefore become ineffective. This was because, although the LUCAS was attached to the patient and the patient was attached to the backboard, there was no direct connection from the LUCAS to the

backboard. Besides the slight stability issue, the LUCAS was found to be very user friendly in both setup and operation.



Figure 3.4.2: The user-friendly operating instructions for the LUCAS

The aspect of the LUCAS device where no flaws could be found was in the device's operation. The device was found to provide perfect 2 inch depth compressions and have perfect rhythm providing 100 compressions every minute. Firefighter Cavan mentioned one situation in which he was operating the LUCAS system and stated that it worked so well that the device actually served as an artificial heart so that the patient was

fully conscious and resuscitated until the device was shut off at which point the patient expired. Another case he spoke of involved the device providing enough energy to completely unblock a clogged artery. One aspect he touched upon was, due to the consistency of the device, should the situation arise where the performance of the paramedics' performance is called into question, the device serves as a legal failsafe. With the LUCAS, the paramedics can guarantee that correct compressions were provided at the correct consistency.



Figure 3.4.3: The LUCAS folded in its pack

The direct, concentrated pressure of the suction cup both provides the proper placement of the pressure and still leaves the landmark areas open. Because of this, when

the paramedic wanted to check the patient's pulse and/or other vitals, all he needed to do was pause the device, take the vitals, and then resume the device's operation. The device was equipped with a feature to save the settings for exactly this purpose. Also, settings would be saved if the battery needed to be replaced in mid-operation as long as the new one was cycled in within 1 minute. This was not found to be an issue because the batteries last for over 45 minutes of operation and simply slide and clip into the top of the machine so changing them would only take 5 to 10 seconds at the maximum. The firefighter went on to mention that during operation, the device was found to be quiet which was a benefit when the paramedics were trying to communicate with each other.



Figure 3.4.4: The LUCAS fully deployed and operating on a CPR training dummy

Overall the firefighter described the LUCAS as the “best designed product ever to be used in an ambulance.” He ended our interview with a few other issues that he would have liked to see improved including the weight of the device and batteries. Also, each device cost approximately \$15000. The Auburn Fire Department was fortunate to have a wealthy benefactor donate two devices. Most local agencies could not afford this type of expense. Finally, the firefighter commented that because of the design of the device, it was difficult to fit over patients who weighed 300 pounds or more.

3.5 Final Design

Using the necessities learned from the interview, the final design was decided upon. The final design would be required to have an expandable frame in order to accommodate victims over 300 pounds as well as have a gripping mechanism that would allow the frame of the device to be universally compatible with any EMS backboard. In order to achieve the expansion on the frame, telescoping arms would be inserted on the top and bottom of the device's frame arms.

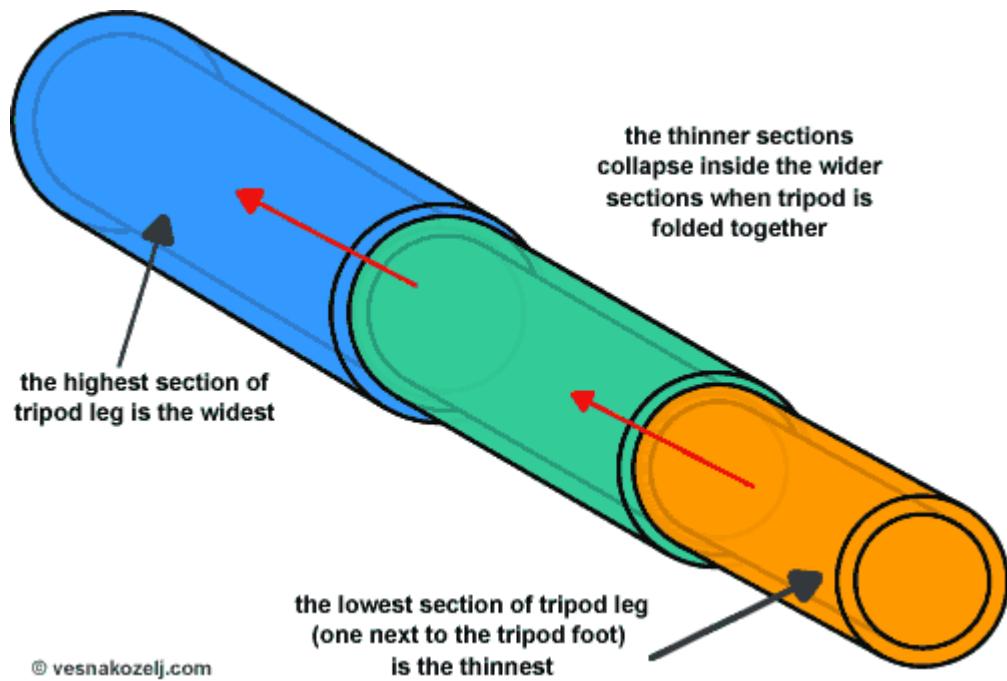


Figure 3.5.1: Simple diagram of a telescoping arm

Telescoping legs, as seen above and in Appendix D, are commonly found in tripods for supporting various items. The design of the leg coupled with a strong, yet lightweight, material would provide ample strength to support the device and normal forces resulting from its operation. The quick expansion and collapse of these legs would

be a key factor. Using a quick-release lever lock would make this possible while still providing a stable lock to keep the arms in place during operation and storage. Locks like these are another common feature seen on tripods as below and in Appendix E.



Figure 3.5.2: Quick release level lock on a telescoping tripod leg

To achieve the universal compatibility with EMS backboards, an easily adjustable gripping mechanism would be required. A practical solution would be to use the design in use in vise-grips (a.k.a. locking pliers).



Figure 3.5.3: Standard vise-grips (a.k.a. locking pliers)

These common tools, as seen above and in Appendix C, provide an ease of operation and the firm grip needed to secure the device to any backboard. Also, they include an easy adjustment feature which would be able to quickly change the width of the grip in order to fit backboards of different thicknesses.

With these improvements incorporated into the existing LUCAS device, a final design was modeled as seen below.

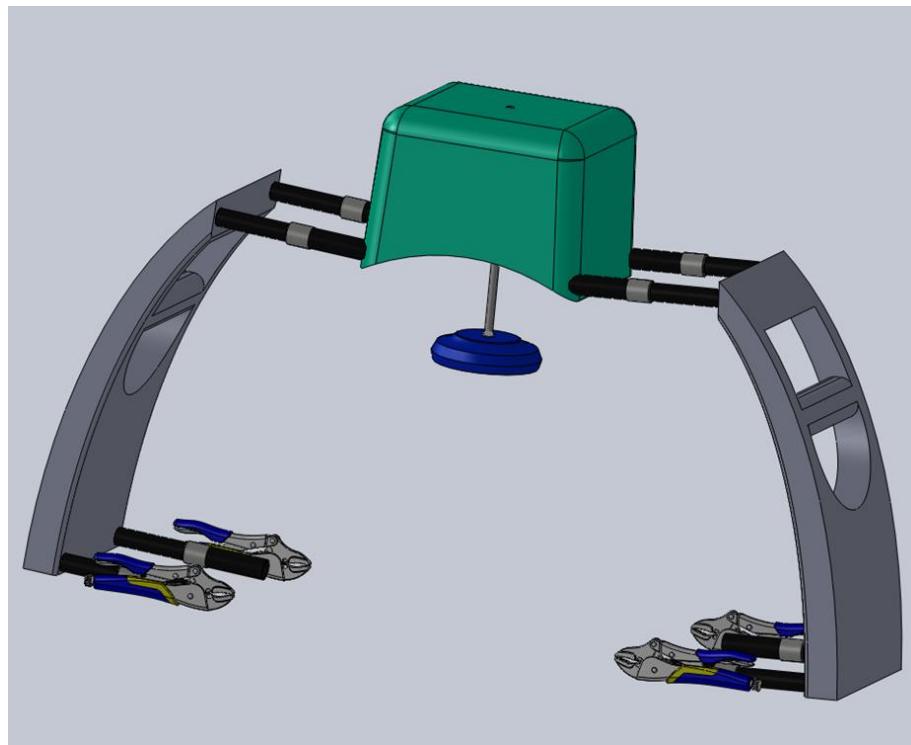


Figure 3.5.4: Computer model of the final design of the improved LUCAS device

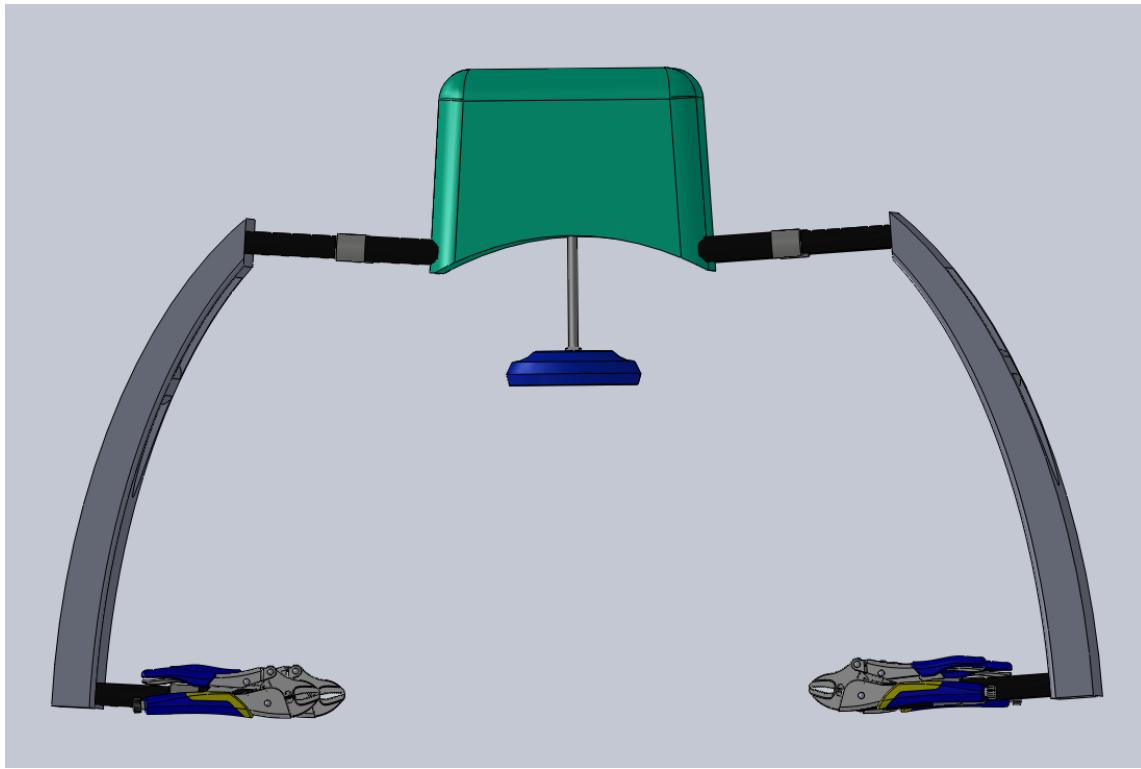


Figure 3.5.5: Side view of computer model of the final design

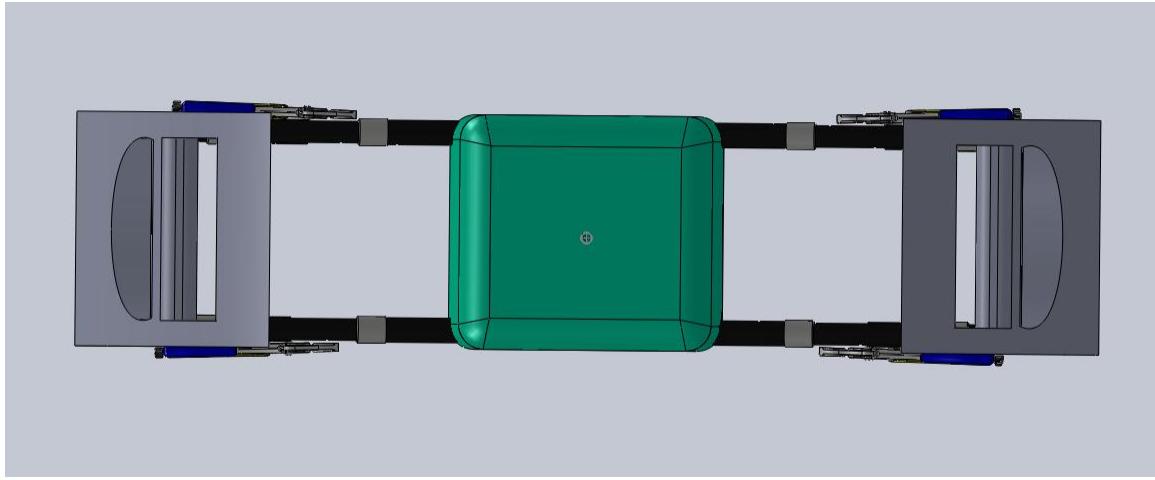


Figure 3.5.6: Top view of computer model of the final design

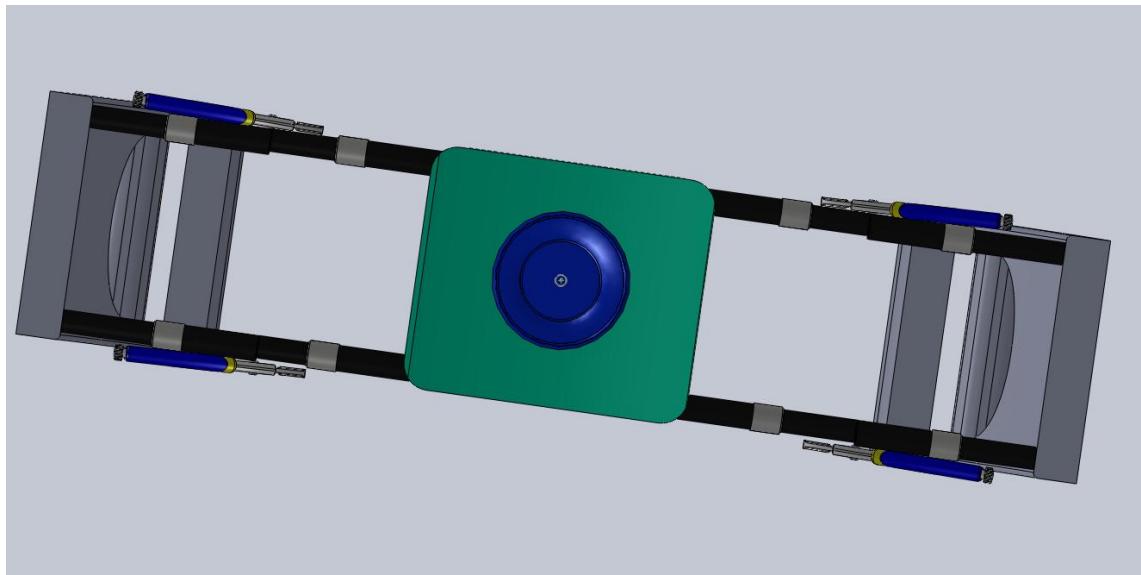


Figure 3.5.7: Bottom view of computer model of the final design

This design incorporates the improved features to solve the two main problems as discussed previously. The final model was designed to be as compactable and portable as the original model.

Chapter 4. CONCLUDING REMARKS

4.1 Conclusion

This project set out to design a brand new product which would change the field of emergency response. After finding out that the product we set out to design already existed, we decided to do what we could to improve the current system. Using interviews with local authorities in the field, we identified the most important issues and created innovative, but simple fixes to each problem. By combining existing designs to a current CPR device, we were able to solve the issues we identified while still allowing the device to be as compact, portable, and easily deployable as the original design.

The final design has great potential to be used by all EMS in any situation. The universality and portability of this device makes it ideal for EMS use. It is hoped that in the future this device will be as widely available as AEDs and therefore be able to prevent more deaths and injuries from heart attacks and CPR respectively.

4.2 Future Possibilities

There are many future possible designs that can result from this project. Possible designs suggested by our advisor during this project included a self contained vest for high-risk victims. Another major idea was to use compressed air to perform the compressions. A third design combined the two previous by being an apparatus that wraps around the victim and uses compressed air distributed on all sides of the body to perform compressions. All of these ideas had pros and cons, but for some of these, current technology is not yet sufficient enough to support the design of these devices.

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Figure Citations

- 3.2.1: "A metal "scoop" backboard and a standard backboard", UMASS Worcester EMS, courtesy of John Wilder
- 3.3.1: "Computer model of the first design revision", Solidworks creation, Tom Killen, Yunsoo Choi
- 3.4.1: "The LUCAS pack", Auburn, MA Fire Department, courtesy of John Wilder
- 3.4.2: "The user-friendly operating instructions for the LUCAS", Auburn, MA Fire Department, courtesy of John Wilder
- 3.4.3: "The LUCAS folded in its pack", Auburn, MA Fire Department, courtesy of John Wilder
- 3.4.4: "The LUCAS fully deployed and operating on a CPR training dummy", Auburn, MA Fire Department, courtesy of John Wilder
- 3.5.1: "Simple diagram of a telescoping arm", www.vesnakozelj.com
- 3.5.2: "Quick release level lock on a telescoping tripod leg", http://www.cameralabs.com/reviews/Manfrotto_190XPROB_tripod/

3.5.3: “Standard vise-grips (a.k.a. locking pliers)”,

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3.5.4: “Computer model of the final design of the improved LUCAS device”, Solidworks creation, Tom Killen, John Wilder

3.5.5: “Side view of computer model of the final design”, Solidworks creation, Tom Killen, John Wilder

3.5.6: “Top view of computer model of the final design”, Solidworks creation, Tom Killen, John Wilder

3.5.7: “Bottom view of computer model of the final design”, Solidworks creation, Tom Killen, John Wilder

Appendices

Appendix A. AutoPulse Technical Specifications (ZOLL Medical Corporation [22])

A.1 Patient Parameters

The AutoPulse is designed for adults with weight of no more than 300 lbs. with chest circumference of 29.9 to 51.2 in. and chest width of 9.8 to 15 in.

Warning: The AutoPulse System is intended for use on adults, 18 years of age or older.

A.2 LifeBand

The latex-free LifeBand is for single-patient use only. The LifeBand consists of a cover plate and two bands integrated with a patient liner and compression pads with a Velcro® fastener.

A.3 Operating Parameters

Table A-1 Operating Parameters

Category	Specifications
Chest displacement	Equal to 20% reduction in anterior-posterior chest depth
Physiological duty cycle	$50 \pm 5\%$
Compression rate	80 ± 5 compressions per minute
Compression modes (user selectable)	<ul style="list-style-type: none"> • 30:2 (30 compressions with 1.5 second ventilation pauses) • 15:2 (15 compressions with 1.5 second ventilation pauses) • Continuous compressions
Ventilation pause (30:2 and 15:2 mode)	Two pauses of 1.5 seconds

A.4 Platform Physical

Table A-2 Physical Specifications

Category	Specifications
Size (LxWxH)	32.5 in by 17.6 in. by 3.0 in.
Weight (excluding AutoPulse Battery)	20.5 lbs
Display	Dot matrix liquid crystal display (LCD), actively backlit, adjustable contrast.

A.5 Battery Physical

Table A-3 Battery Specifications

Category	Specifications
Size (LxWxH)	11.5 in by 3.2 in. by 2.2 in,
Weight	5.1 lbs
Type	Rechargeable Nickel-Metal Hydride (NiMH)
Battery voltage (nominal)	32.4V
Capacity	3200 mAh (typical)
Initial Battery runtime (nominal patient)	30 minutes (typical)
Maximum Battery charge time	Less than 4 ¼ hours at 77°F
Battery test-cycle time	Less than 10 hours per test-cycle session; up to three consecutive sessions possible.
Required replacement interval	100 full charge/discharge cycles. Note: The Battery will not operate after 100 full charge/discharge cycles.

Appendix B. Interview Questions

- Have you ever operated the AutoPulse in the field?
- Do you find that it's more effective than manual chest compressions?
- Does the Autopulse effectively distribute the pressure enough to prevent causing further injury to the patient?
- Have you experienced any issues while operating the Autopulse?
- Has it ever failed in a mechanical sense? (e.g. The LifeBand suddenly stopped doing the chest compressions)
- Is there anything at all you would suggest about the device that could be improved?
- Are there any other methods to provide pressure for compressions rather than the current method which can often cause cracked ribs?
- If this machine effective enough in the field to account for the high cost?
- Is the Autopulse “user friendly” enough to be made available to the public like the AED has been?
- Are AEDs used for all cardiac arrest patients?
- Would it make the process of CPR more efficient if and AED was integrated with the Autopulse?
- Are there any other issues that arise with CPR that we should be addressing?

Appendix C. Patents for vise-grips (a.k.a. locking pliers)

Patent for vise-grips (a.k.a. locking pliers)



(12) **United States Patent**
Wrigley et al.

(10) **Patent No.:** US 6,199,458 B1
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(54) **LOCKING PLIERS**

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(52) **U.S. Cl.:** 81,319

(58) **Field of Search:** 81,319, 367-383,5, 81,418, 424,5, 426, 426,5

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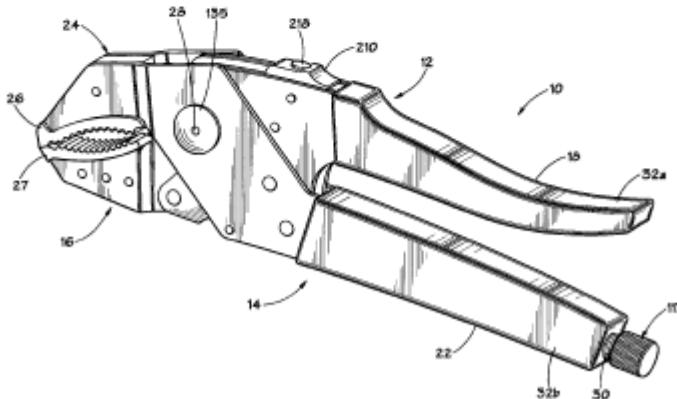
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(57) **ABSTRACT**

A pair of locking pliers includes a first assembly defining a first handle and a first jaw, a second handle, and a second jaw rotatably coupled to the first assembly and the second handle. The second handle is movable relative to the first handle to move the second jaw relative to the first jaw. An improved lock and release mechanism has a first setting wherein the second jaw is freely movable relative to the first jaw, a second setting wherein the second jaw locks at a preset distance from the first jaw when the second handle is moved toward the first handle, and a third setting wherein the second jaw unlocks when the second handle is moved toward the first handle.

26 Claims, 14 Drawing Sheets



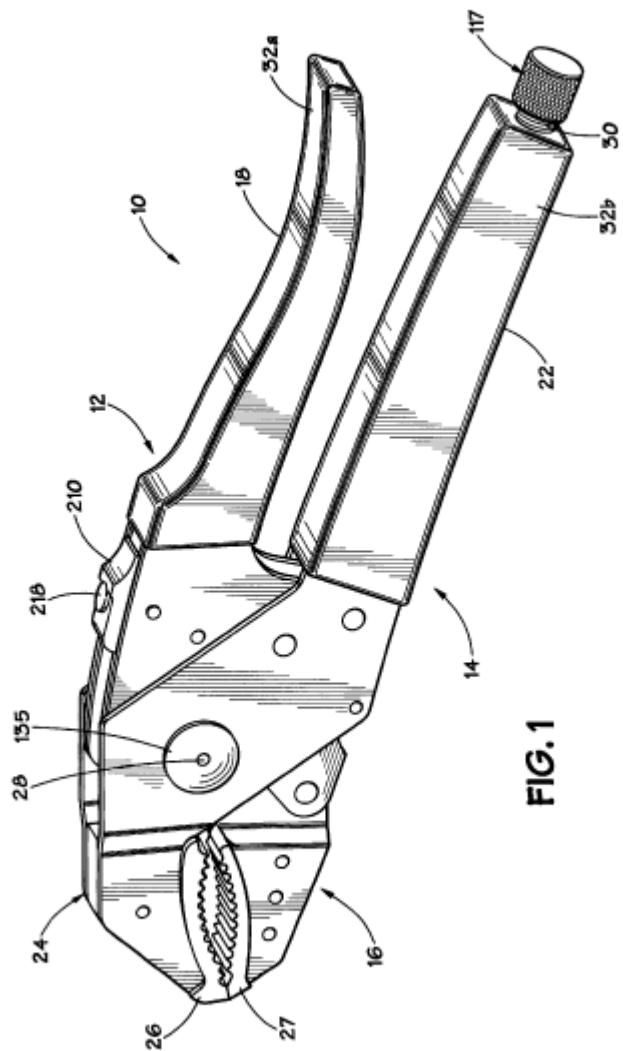


FIG. 1

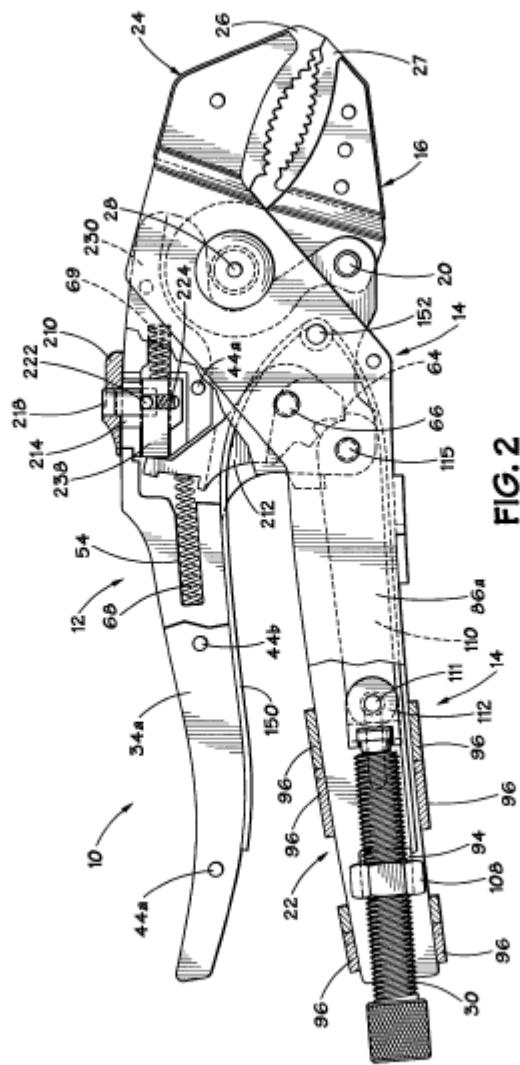
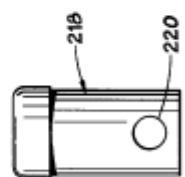
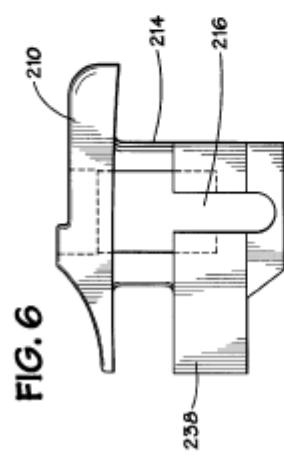
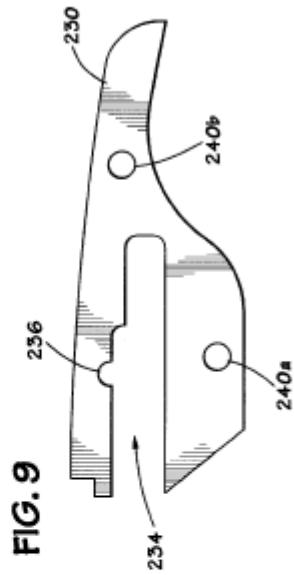
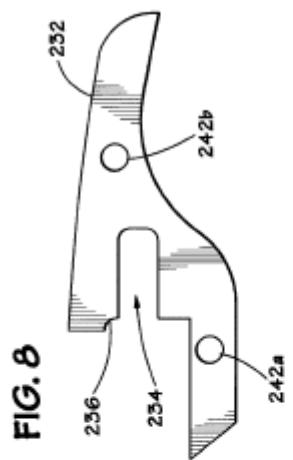
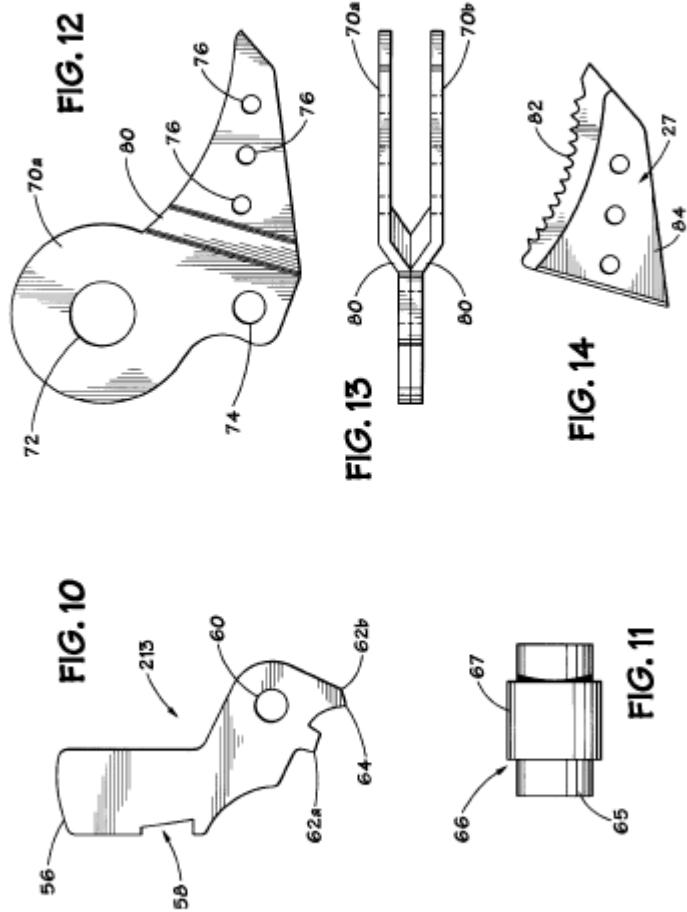
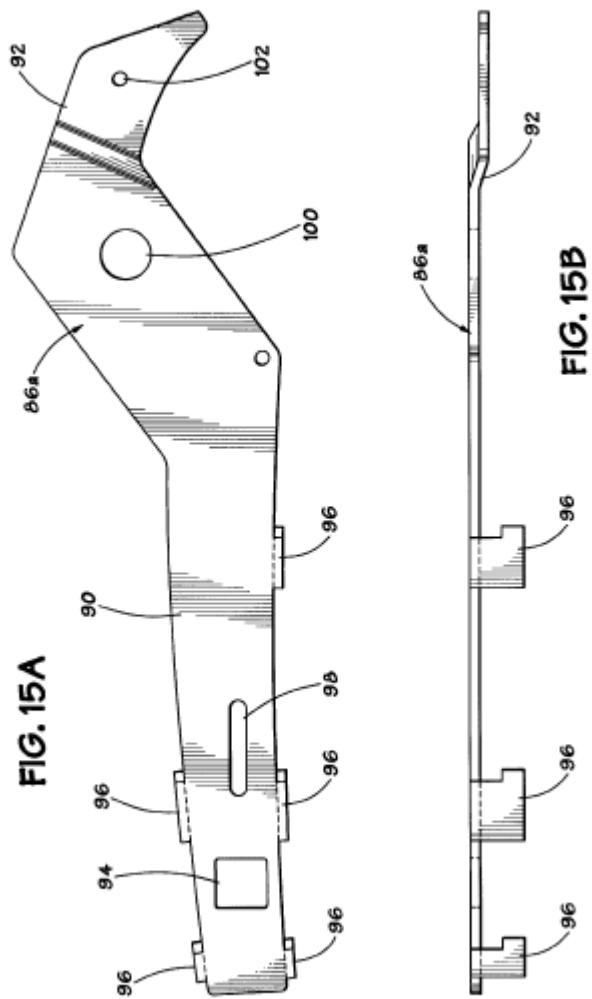


FIG. 2







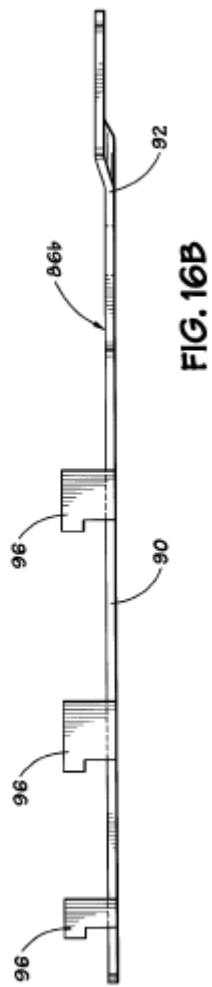
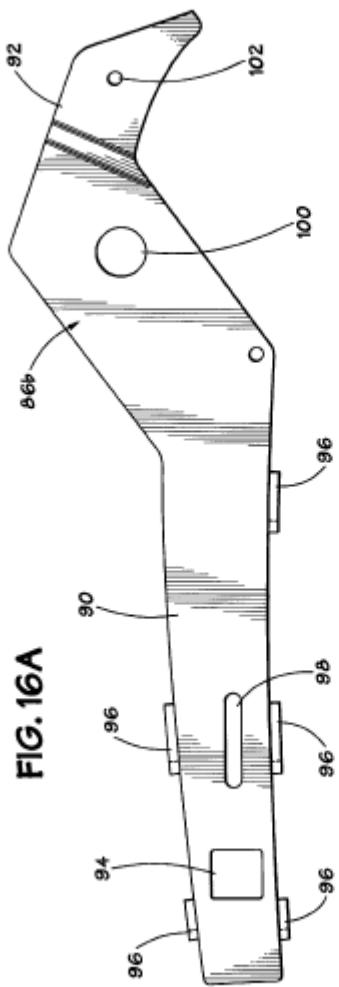


FIG. 26C

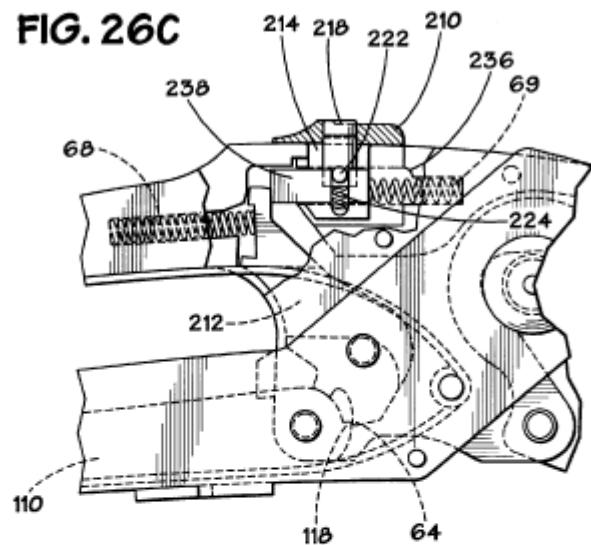
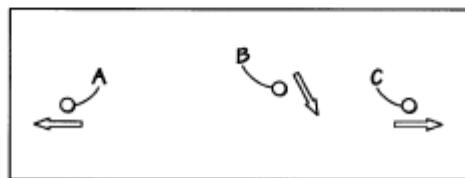
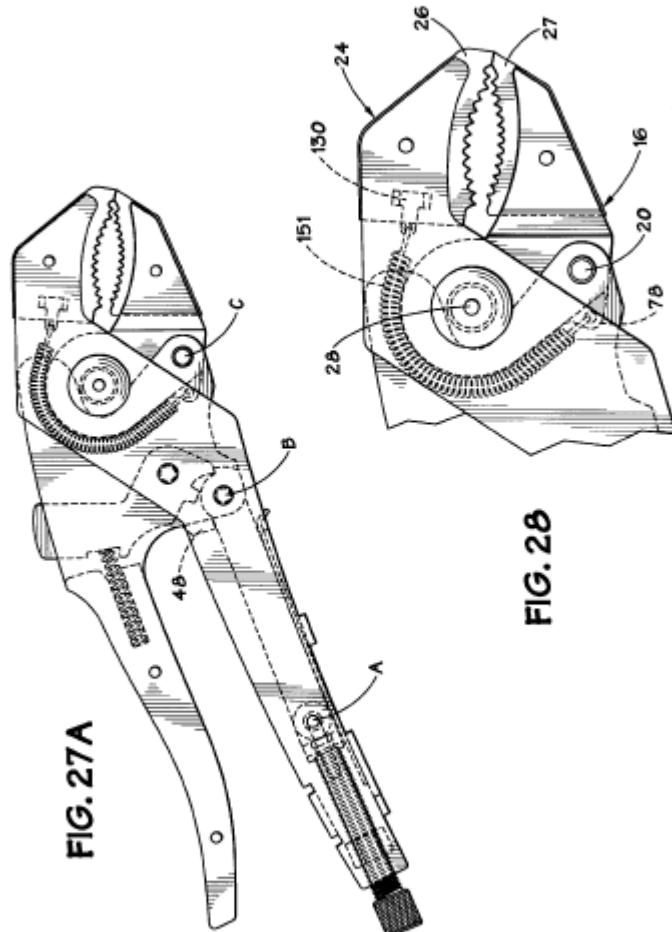
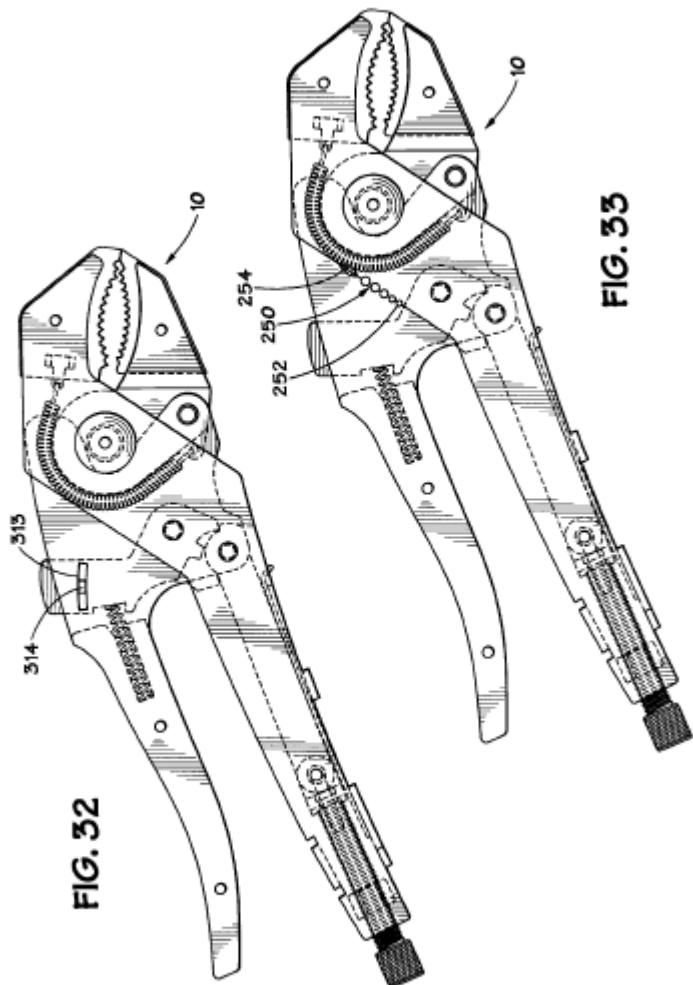


FIG. 27B







1**LOCKING PLIERS****CROSS-REFERENCE TO RELATED APPLICATION**

This application claims the benefit of U.S. Provisional Application Ser. No. 60/047,688, entitled "Locking Pliers," filed May 27, 1997 by the same inventors, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

The invention relates generally to locking pliers, and more particularly, to locking pliers having an improved locking and release mechanism.

2. Description of Related Art

Pliers having locking mechanisms to maintain the pliers jaws in a fixed position are well known. Such pliers typically include an adjustment mechanism that sets the pliers jaws at roughly a desired distance apart, and a toggle mechanism locks the pliers about a workpiece when the pliers handles are squeezed together. In known locking pliers, the action of squeezing the handles together drives the toggle mechanism beyond a "dead center point," to lock the jaws onto the workpiece.

Known locking pliers typically include a fixed handle and jaw with a movable jaw coupled thereto. The movable jaw is operated by a movable lever that has one end coupled to the movable jaw. The opposite end of the movable lever defines a movable handle. A link member connects the fixed handle to a forward section of the movable lever intermediate the movable handle and the movable jaw. The combination of the link member and the forward section of the movable lever constitute the toggle mechanism for locking and releasing the pliers. An adjustment mechanism, such as an adjustment screw, laterally moves the end of the link member connected to the fixed handle to adjust the separation of the fixed and movable jaws. A spring may be employed, for example, between the movable jaw and the fixed handle, to normally bias the jaws apart.

The above described arrangement of the link member and forward section of the movable lever define three pivot points around which the locking mechanism of typical prior art locking pliers operates. The first pivot point is the point at which the movable lever connects to the movable jaw. The second pivot point is located where the link member connects to the forward section of the movable lever, and the third pivot point occurs at the opposite end of the lever member, where the link member connects to the fixed handle.

When the locking pliers handles are apart (jaws apart, or open), the toggle mechanism (the forward section of the movable lever and the link member) forms an obtuse angle. As the handles are brought together, the jaws close towards each other, and the angle formed by the toggle mechanism approaches a straight line. The "dead center point" occurs when toggle member forms a straight line; in other words, when the three pivot points are in a line. As the handles continue to move together, the second pivot point passes the dead center point, and movement of the movable handle is halted, usually by the one or both of the forward section of the movable lever or the link member contacting a stop or the fixed handle. The jaws will maintain their closed position until the second pivot point is forced back across the dead center point by actuation of a release lever or other actuator provided on the fixed handle.

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Unfortunately, there are several shortcomings associated with known locking pliers, such as those described above using a "dead center point" locking operation. First, the action of releasing the locked pliers jaws by pushing the middle pivot point back across the dead center point often requires two hands. The user has one hand gripping the handles of the pliers, and the user's other hand is required to activate the release. This two-hand requirement is simply unacceptable for many tasks requiring the use of a pair of pliers.

Further, the jaws of prior art locking pliers will lock any time the handles are manipulated such that the middle pivot point crosses the dead center point. Often, it is desirable to operate a locking pliers as a spring loaded pliers, for example, to achieve a "ratcheting" action when turning a nut or bolt. However, with known locking pliers, the jaws lock each time the handles are squeezed together, and the release mechanism must be actuated to unlock the pliers. This necessitates repeatedly locking and unlocking the pliers whenever repeated opening and closing of the jaws is required.

Moreover, the release lever of many prior art locking pliers may cause an uncontrolled or unintentional unlocking of the pliers. The release mechanisms of typical prior art locking pliers perform the unlocking function by pushing the center pivot point back across the dead center point. Once the center pivot point passes the dead center point from the locked position, the jaws are not maintained in their closed position. Further, since most known locking pliers are spring biased to an open position (jaws apart), as soon as the center pivot point passes the dead center point, the pliers will "spring" open. This can create several difficulties.

For example, if the locking pliers are being used in a clamping operation, the pliers will completely release if the release lever is inadvertently activated. During operations requiring locking and unlocking of the pliers, the user often does not have a free hand available to activate the release lever. Hence, the user may be required to release his grip from the handles, at least partially, to activate the release. If the user does not maintain control of the handles when the release is activated, the pliers may spring out of the user's hands, or possibly spring open and strike the user's hand.

Still further, many prior art locking pliers designs have a toggle mechanism including the link member described above, extending between the fixed handle and the movable lever. The combination of the handles and the link member produce various "pinch points." These pinch points are locations where material, such as a user's clothes or a finger, may be caught and pinched as the handles are moved relative to each other.

Thus, a need exists for locking pliers that address these, and other, shortcomings of the prior art.

SUMMARY OF THE INVENTION

In one aspect of the present invention, a pair of locking pliers includes a first assembly defining a first handle and a first jaw, and a second handle. A second jaw is rotatably coupled to the first assembly and the second handle, such that the second handle is movable relative to the first handle to move the second jaw relative to the first jaw. A locking mechanism interconnects the first assembly and the second handle. A release mechanism is rotatably coupled to the second handle. The release member interacts with the locking mechanism to fix the second jaw in a fixed position relative to the first jaw.

In another aspect of the present invention, a pair of locking pliers includes a first assembly defining a first

handle and a first jaw, a second handle, and a second jaw rotatably coupled to the first assembly and the second handle. The second handle is movable relative to the first handle to move the second jaw relative to the first jaw. A release mechanism has a first setting wherein the second jaw is freely movable relative to the first jaw, a second setting wherein the second jaw locks at a preset distance from the first jaw when the second handle is moved toward the first handle, and a third setting wherein the second jaw unlocks when the second handle is moved toward the first handle.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. 1 is a perspective view illustrating an exemplary pair of locking pliers in accordance with an embodiment of the present invention;

FIG. 2 is a side view of the exemplary pair of locking pliers illustrated in FIG. 1, illustrating several interior components in dashed lines;

FIGS. 3A-3C illustrate a side view and bottom views of the main components of an upper handle assembly in accordance with an embodiment of the present invention;

FIG. 4 is a side view of an upper handle spacer in accordance with an embodiment of the present invention;

FIG. 5 is a side view of a pivot release member of a release mechanism in accordance with an embodiment of the present invention;

FIG. 6 is a side view of a release slide of a release mechanism in accordance with an embodiment of the present invention;

FIG. 7 is a side view of a release button of a release mechanism in accordance with an embodiment of the present invention;

FIG. 8 is a side view of a middle release spacer of a release mechanism in accordance with an embodiment of the present invention;

FIG. 9 is a side view of an outer release spacer of a release mechanism in accordance with an embodiment of the present invention;

FIG. 10 is a side view of a pivot release member in accordance with an alternate embodiment of the present invention;

FIG. 11 is a side view of a rotation pin in accordance with an embodiment of the present invention;

FIG. 12 is a side view of a lower jaw support in accordance with an embodiment of the present invention;

FIG. 13 is a bottom view of right and left side lower jaw supports as assembled in an embodiment of the present invention;

FIG. 14 is a side view of a lower jaw component in accordance with an embodiment of the present invention;

FIGS. 15A and 15B are side and bottom views of a right side lower handle in accordance with an embodiment of the present invention;

FIGS. 16A and 16B are side and bottom views of a left side lower handle in accordance with an embodiment of the present invention;

FIG. 17 is a partial bottom view illustrating the lower handle assembly of an embodiment of the present invention;

FIG. 18 illustrates an adjustment nut as it is fixed in place by the components of the lower handle assembly in an embodiment of the present invention;

FIG. 19 is a side view illustrating a locking arm in accordance with an embodiment of the present invention;

FIGS. 20A and 20B illustrate side and front views of an adjustment bracket in accordance with an embodiment of the present invention;

FIG. 21 is a side view illustrating an exemplary adjustment screw in accordance with an embodiment of the present invention;

FIG. 22 is a side view illustrating an upper jaw component in accordance with an embodiment of the present invention;

FIG. 23 is a bottom view illustrating an example of the laminate stack formed by various components of an embodiment of the present invention;

FIGS. 24A and 24B are front and side views of a pivot washer in accordance with an embodiment of the present invention;

FIG. 25 is a side view illustrating an anti-impingement pin in accordance with an embodiment of the present invention;

FIGS. 26A-26C are partial side views illustrating the operation of the release mechanism in an embodiment of the present invention;

FIG. 27A is a side view, and FIG. 27B is a conceptual diagram, illustrating the operation of the anti-past center stop of an embodiment of the present invention;

FIG. 28 is a partial side view illustrating an alternative embodiment of the present invention, in which the main biasing spring comprises an extension spring;

FIG. 29 is a side view illustrating an exemplary lower jaw support suitable for use with the embodiment of the present invention illustrated in FIG. 28;

FIGS. 30A and 30B are side and bottom views of an exemplary leaf spring suitable for use in the lower handle assembly of an embodiment of the present invention;

FIG. 32 is a side view illustrating an alternate embodiment of a release actuator in accordance with the present invention; and

FIG. 33 is a side view illustrating a locking pliers in accordance with an alternate embodiment of the present invention including wire strippers and a wire cutter.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementa-

tion to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

Turning to the drawings and, in particular, to FIG. 1, a perspective view of a pair of locking pliers 10 in accordance with an embodiment of the present invention is provided. In general, the pair of locking pliers 10 includes an upper handle assembly 12, a lower handle assembly 14, and a lower jaw assembly 16. The upper handle assembly 12 defines an upper handle 18 that extends from one end of the pliers 10. The upper handle assembly 12 is rotatably coupled to the lower jaw assembly 16 by a pin 28 (not visible in FIG. 1). An actuator 210 of a release mechanism 21 (not illustrated in FIG. 1) extends from the upper handle assembly 12.

The lower handle assembly 14 defines a lower handle 22 that extends in the same general direction as the upper handle 18. The lower handle assembly 14 also defines a head portion 24. An upper jaw member 26 is positioned within the head portion 24, and a lower jaw member 27 is positioned within lower jaw assembly 16. A pivot pin 28 passes through the lower handle assembly 14 and the lower jaw assembly 16, rotatably coupling the lower jaw assembly 16 to the lower handle assembly 14. The knurled end of an adjustment screw 30 extends from one end of the lower handle 22.

In the embodiment of FIG. 1, upper and lower grips 32a and 32b, formed of vinyl or other suitable material, are positioned about the upper and lower handles 18 and 22.

In operation, the user of the pair of locking pliers 10 may, through adjustment of the adjustment screw 30, preset the distance that will exist between the upper jaw member 26 and lower jaw member 27 in lower jaw assembly 16 when the pliers 10 are in their closed and locked position. Once the adjustment screw 30 is set, the pliers 10 may be placed in their closed and locked position by bringing the lower handle 22 towards the upper handle 18 (or vice versa) until the pliers 10 reach a locked and closed position. Once the pair of pliers 10 is placed in its closed and locked position, it may be released from that position through activation of the release actuator 210.

FIG. 2 shows a side view of the pliers 10 of FIG. 1, with many of the interior elements of the pliers 10 illustrated using dashed lines. The upper and lower grips 32a, 32b are not illustrated in FIG. 2. Referring to FIGS. 2 through 4, the upper handle assembly 12 comprises three major components: a right side upper handle portion 34a (locking down—the topmost upper handle portion in FIG. 2); a left side upper handle portion 34b (locking down—the bottom upper handle portion, not visible in FIG. 2); and an upper handle spacer 36 (not visible in FIG. 2). In general, the right and left side upper handle portions 34a and 34b and the upper handle spacer 36 are coupled together to form the upper handle 18 and an upper handle cavity within which is positioned the release mechanism 21.

In the embodiment of FIG. 2, both the right and left side upper handle portions 34a and 34b are constructed (blanked) from 1070 steel that has been cut through use of a progressive stamping die and has been heat treated and blackened via a black oxide coating. Other coatings, such as zinc chromate, would also be suitable. Still further embodiments using materials other than steel are envisioned. Both the right and left upper handle portions 34a and 34b may be constructed (blanked) from a piece of material of the form of the component designated 34 illustrated in FIG. 3A.

Referring FIG. 3A, the illustrated component 34 has a first extension that defines a handle portion 40 and a main body

portion 42. Pin-receiving bores 44a, 44b, 44c are constructed (blanked and countersunk) in the handle portion 40 and three pin-receiving bores 46a, 46b, 46c are formed in the main body portion 42. The embodiment of the component 34 illustrated in FIG. 3A further defines a pin-receiving bore 47 that is smaller than the pin-receiving bores 46a, 46b, 46c. The main body portion 42 also defines an extension member 48 that extends from the main body portion 42 back towards the handle portion 40. The main body portion 42 further defines a cut-out section 50 that is generally opposite the extension member 48.

The right and left upper handle portions 34a and 34b that define the upper handle assembly 12 are generally identical with the exception of the handling of the extension member 48. To form the right side upper handle portion 34a the extension member 48 is bent in the direction illustrated in FIG. 3B by a pre-defined amount. In the illustrated example, the pre-defined amount is about 90 degrees. To form the left side upper handle portion 34b, the extension member 48 is bent in the direction opposite that illustrated in FIG. 3B. The bend used to form the left side upper handle portion 34b is generally illustrated in FIG. 3C. In the illustrated embodiment, the bend used to form the left side upper handle portion 34b is also about 90 degrees. In an alternative embodiment, the extension member 48 of both the right and left side upper handle portions 34a, 34b is bent about 30 degrees.

FIG. 4 provides an illustrative example of the upper handle spacer 36. In the illustrative example, the upper handle spacer 36 is formed of injection molded Delrin plastic. In general, the upper handle spacer 36 follows the general profile of the handle portions 40 of the right and left upper handle portions 34a and 34b. The upper handle spacer 36 defines two pin-receiving bores 52a and 52b that are arranged, constructed (blanked and countersunk), and sized in a manner similar to bores 44a, 44b of component 34. The upper handle spacer 36 also defines an elongated channel 54.

Referring back to FIG. 2, the release mechanism 21 will be discussed in greater detail. In general, the release mechanism 21 includes a pivot release member 212 that may be formed from 1070 heat-treated steel that has been appropriately cut through use of a stamping die. An exemplary pivot release member 212 is illustrated in FIG. 5. The steel used to form the pivot release member 212 may be blackened in a manner similar to that used to construct component 34, although in one embodiment no blackening is used such that the pivot release member 212 has an appearance different from that of the right and left upper handle portions 34a and 34b.

Because the pivot release member 212 experiences movement during the use of the pliers 10, it may be coated with an appropriate protective coating, such as 0.0001 inch of zinc chromate. In general, the thickness of the material used to form the pivot release member 212 will be greater than that used to form the right and left upper handle portions 34a and 34b. For example, if steel having a thickness of 0.090 inches is used to form the right and left upper handle portions 34a and 34b, steel having a thickness of 0.170 inch may be used to form the pivot release member 212. A pin-receiving bore 60 passes through the pivot release member 212 and first and second extension surfaces 62a and 62b form a locking ledge 64. The pivot release member 212 further defines a slot 58.

The release mechanism 21 further includes a release slide 214. An embodiment of the release slide 214 is illustrated in FIG. 6. The release slide 214 includes an actuator portion 210, which, as illustrated in FIG. 1 and FIG. 2, protrudes

above the upper handle assembly 12. The release slide 214 further defines a cavity 216 that is adapted to receive a release button 218. An embodiment of the release button 218 is illustrated in FIG. 7. The embodiment of the release button 218 defines a bore 220 extending therethrough, generally transverse to the main axis of the release button 218. A release pin 222 is seated in the bore 220, such that a portion of the release pin 222 extends from either side of the release button 218. A release spring 224 is received within the cavity 216, and the release button 218, with the release pin 222 seated in the bore 220, is also situated within the cavity 216 such that the release spring 224 biases the release button 218 in an upwards direction.

First and second outer release spacers 230 are situated between the right and left upper handle portions 34a and 34b in the upper handle assembly cavity, and a middle release spacer 232 is sandwiched between the first and second outer release spacers 230. The first and second outer release spacers 230 are identical in shape, and are illustrated in FIG. 8. The middle release spacer 232 is illustrated in FIG. 9. The outer release spacers 230, and the middle release spacer 232 each define a channel 234 therein and a notch 236 that is adapted to receive a channel 234 portions of the release pin 222 extending from either side of the release button 218. Each of the outer release spacers 230 defines two pin receiving bores 240a, 240b extending therethrough, and the middle release spacer 232 defines two corresponding pin-receiving bores 242a, 242b.

The manner in which the right and left upper handle portions 34a and 34b, the upper handle spacer 36, and the release mechanism 21 are coupled together to form the upper handle assembly 12 is generally illustrated in FIG. 2. Referring to FIG. 2, the upper handle assembly 12 may be formed by sandwiching the upper handle spacer 36, the pivot release member 212, and the remaining components of the release mechanism 21 between the right and left upper handle portions 34a, 34b, with the actuator 210 of the release mechanism 21 extending from the right and left upper handle portions 34a, 34b.

A rotation pin 66, which passes through the bore 69 of the pivot release member 212 and bores 46a of the right and left upper handle portions 34a, 34b, serves to keep the pivot release member 212 in proper alignment with respect to the right and left upper handle portions 34a and 34b. One suitable rotation pin 66 is illustrated in FIG. 11. In general, the rotation pin 66 has an intermediate portion 67 of a fine diameter and two projecting portions 65 of a lesser diameter. The projecting portions 65 are sized to be received by the corresponding bores 46a in the right and left upper handle portions 34a and 34b. The rotation pin 66 may be of standard construction and may be formed from either hot or cold rolled steel. In one embodiment, the rotation pin 66 is not fully hardened, but is only toughened to approximately 44-48 on the Rockwell C scale.

The upper handle assembly 12 may be held together by three upper handle rivet pins 67a, 67b, 67c that are positioned through the pin-receiving bores 44a, 44b, 44c of the right and left upper handle portions 34a and 34b, the pin-receiving bores 52a, 52b of upper handle spacer 36, the pin-receiving bores 240a of the outer release spacers 230, and the pin-receiving bore 242a of the middle release spacer 232. Additionally, a pin 67d extends through the pin receiving bores 240b of the outer release spacers 230 and the pin-receiving bore 242b of the middle release spacer 232, further keeping the middle release spacer 232 properly sandwiched between the outer release spacers 230. The use of pins 67a-67d is exemplary only; other suitable fasteners may be employed.

In the illustrative embodiment of FIG. 2, the channel 54 defined by the upper handle spacer 36, together with the right and left upper handle portions 34a, 34b, form a cavity within which a pivot release spring 68 is situated. The pivot release spring 68 functions to bias the pivot release member 212 towards the head portion 24 of the upper handle assembly 12, and against the lower portion 238 of the release slide 214. The right and left upper handle portions 34a, 34b, along with the channel 234 defined by the outer and middle release spacers 230, 232 forms another cavity within which a release slide spring 69 is situated, pushing the pivot release member 212 opposite the pivot release spring 68.

An alternative embodiment of the release mechanism is illustrated in FIG. 10. In the illustrated embodiment, the release mechanism generally comprises a single pivot release member 213, that may be formed in a manner similar to the pivot release member 213 of the release mechanism 21 disclosed herein in conjunction with FIGS. 5-9. An upper extension surface 56 of the pivot release member 213 protrudes from the upper handle assembly 12. This upper extension surface 56 may be depressed by the user of pliers 10 to disengage the pair of pliers from its closed and locked position. Because the human user of the pliers 10 will apply pressure to the pivot release member 213 to release the pliers 10 from their closed and locked position, the pivot release member 213 may be jumbled to smooth its surface. The lower portion of the pivot release member 213 is formed in a manner similar to the pivot release member 212 of the embodiment illustrated in FIG. 5. The operation of the release mechanism 21 is described further herein below.

As illustrated in FIG. 2, the upper handle assembly 12 is coupled to the lower jaw assembly 16 by a pin 20. The pin 20 may be formed in a manner similar to the rotation pin 66 illustrated in FIG. 11. FIGS. 12-15 illustrate the lower jaw assembly 16 in greater detail. In general, the lower jaw assembly 16 is formed from two substantially-identical components 70a and 70b and a lower jaw member 27. FIG. 12 provides an illustrative example of the component 70a. In general, the component 70a may be formed of hardened, blackened 1070 steel. The component 70a defines a large bore 72 for receiving the pivot pin 28, and a first small bore 74 sized to receive the pin 20 for coupling the lower jaw assembly 16 to the upper handle assembly 12. Component 70a also defines one or more small bores 76. In the embodiment illustrated, there are three small bores 76. The component 70a is bent-out at region 80 in a manner illustrated more clearly in FIG. 13. Component 70b is substantially identical to component 70a, except that the bend at region 80 in component 70b is opposite to that of component 70a.

Components 70a and 70b may be brought together to form a lower jaw cradle in the manner illustrated in FIG. 13. The lower jaw member 27, which is illustrated in FIG. 14, may be placed in the lower jaw cradle to form the lower jaw assembly 16. As illustrated in FIG. 14, the lower jaw member 27 defines a toothed jaw surface 82 and a lower extension surface 84. In one embodiment the lower jaw element 27 is formed of powdered metal that has been formed in an appropriate mold and that has been manufactured to have a hardness of approximately 52 on the Rockwell C scale. Alternatively, the lower jaw member 27 may be of a laminated construction of similar material as the components 70a and 70b of the lower jaw assembly 16.

In the illustrated embodiment, the width of the toothed jaw surface 82 is greater than the width "d" of the lower jaw cradle and the width of the lower extension surface 84 is less than the width "d" of the lower jaw cradle (illustrated in FIG. 13). As such, the lower jaw element 27 may be placed in the

lower jaw cradle such that the components 70a and 70b support the toothed jaw surface 82 of the lower jaw element 27. Rivet pins 85 may be positioned through the bores 76 in components 70a and 70b and corresponding bores 77 in the lower jaw element 27. The rivet pins 85 may be of a standard construction, 1008 SAIP.

Referring to FIG. 2 and FIGS. 15-18, an embodiment of the lower handle assembly 14 will next be described. In general, the lower handle assembly 14 is formed from a right side lower handle portion 86a (looking down—the topmost lower handle portion in FIG. 2) and a left side lower handle portion 86b (looking down—the bottom lower handle portion, not shown in FIG. 2). The right and left side lower handle portions 86a and 86b are coupled together and define a cavity therebetween. As discussed in more detail below, an adjustment mechanism, comprising the adjustment screw 30, an adjustment nut 108, and a connecting arm 110, is positioned within the cavity defined by the lower handle assembly 14.

The right and left side lower handle portions 86a, 86b may be formed from the same materials of and in the same manner of the right and left upper handle portions 34a, 34b. Unlike the right and left upper handle portions 34a, 34b, however, the right and left lower handle portions 86a, 86b are not identical. FIGS. 15A and 16A show side views of the right and left side lower handle portions 86a, 86b, respectively. The right and left side lower handle portions 86a, 86b each define a handle portion 90 and an offset head portion 92. The handle portions 90 each define a nut-receiving slot 94. In the embodiment illustrated, the nut receiving slot 94 of the lower left side handle portion 86b has a width that is less than the corresponding width of the nut-receiving slot 94 of the right side lower handle portion 86a. Located proximate to the nut-receiving slots 94 are a plurality of downwardly extending, generally L-shaped locking tabs 96. Each of the right and left side lower handle portions 86a, 86b define a pin receiving slot 98 formed at a position adjacent the nut-receiving slot 94. Two bores 100, 102 are formed in the offset head portion 92 of the right side lower handle portions 86a, 86b.

FIG. 17 is a partial bottom view, illustrating the right and left side lower handle portions 86a, 86b in their assembled configuration. When placed in their respective, opposing positions, the locking tabs 96 on the right side lower handle portion 86a are mirror images of the locking tabs 96 on the left side lower handle portion 86b. The locking tabs 96 are simply interlocked to couple the right and left side lower handle portions 86a, 86b together.

Referring to FIG. 2, it may be noted that the novel configuration of the right and left lower handle portions 86a, 86b and, in particular, the configuration of the nut-receiving slots 94 and the L-shaped locking tabs 96, allow for economical and efficient assembly of the pair of pliers 10. Specifically, to assemble the pliers 10, an adjustment nut 108 is placed in the slot 94 of the left side lower handle portion 86b. The adjustment screw 30 is then threaded through the adjustment nut 108. Alternatively, the adjustment screw 30 may be threaded through the adjustment nut 108 prior to the nut 108 being positioned within the slot 94.

Once the adjustment nut 108 and the adjustment screw 30 are positioned within the slot 94 of the left side lower handle portion 86b, the right side lower handle portion 86a is positioned such that its slot 94 surrounds the adjustment nut 108. The right side lower handle portion 86a is then "snapped" into place such that its L-shaped locking tabs 96 engage the locking tabs 96 of the left side lower handle

portion 86b. FIG. 18 generally illustrates the manner in which the adjustment nut 108 is held in place by the interlocked nature of the right and left side lower handle portions 86a, 86b. The use of the inter-locking locking tabs 96 in the illustrated embodiment of the present invention allows for efficient construction of the locking pliers 10 without time-consuming and costly brazing or welding techniques.

Referring back to FIG. 2, the adjustment screw 30 and the adjustment nut 108 are positioned and held in the cavity formed by the lower handle assembly 22 in the manner discussed above. The adjustment screw 30 is coupled to a connecting arm 110 by an adjustment bracket 112. Exemplary embodiments connecting arm 110, the adjustment bracket 112, and the adjustment screw 30 are illustrated in greater detail in FIGS. 19-21, respectively.

In general, the adjustment bracket 112 is coupled to the adjustment screw 30 via a slot 113 formed in the adjustment bracket 112 and a pin 115 formed in the adjustment screw 30. As illustrated in FIG. 21, the adjustment screw 30 defines a pin member 115 that may be received in the slot 113 of the adjustment bracket 112. The exemplary adjustment screw 30 also defines a flared end 117 that projects from the lower handle 22 for use in adjusting the locked and closed position of the locking pliers 10. In one embodiment, only the end of adjustment screw 30 near the pin 115 is hardened.

Referring back to FIG. 2, the adjustment bracket 112 may be coupled to the connection arm 110 via a rivet pin 111. The rivet pin 111 may extend through the adjustment bracket 112 and into the slots 98 of the right and left lower handle portions 86a and 86b. Referring to FIG. 19, the connection arm 110 has a first end that defines a first bore 114 for receiving the rivet pin 111 for coupling the connection arm 110 to the adjustment bracket 112. The connection arm 110 also has a second end defining a second bore 116 for receiving a rivet pin 115 for connecting the connection arm 110 to the upper handle assembly 12. The second end of the connection arm 110 also defines a locking extension 118 that is shaped to be received by the locking ledge 64 of the pivot release lever 212 of the release mechanism 21. The second end of the connection arm 110 is coupled to the upper handle assembly 12 by the pin 115 that passes through the bore 116 of the connection arm 110 and the bores 46b of the right and left upper handle portions 34a and 34b.

As illustrated in FIG. 2, the lower handle assembly 14 defines a head portion 24 within which is positioned the upper jaw element 26. In general, the right and left side lower handle portions 86a and 86b form an upper jaw cradle that receives the upper jaw element 26 in a manner similar to the manner in which the lower jaw cradle receives the lower jaw element 27. Specifically, as illustrated in FIG. 22, the upper jaw element 26 includes a toothed jaw surface 122 and an upper extension portion 124. In the illustrated embodiment, upper extension portion 124 is sized to fit within the upper jaw cradle, and the toothed jaw surface 122 is of a width that is greater than the width of the upper jaw cradle, such that the upper extension surface 124 may be placed within the upper jaw cradle with the projecting head portions 92 of the right and left lower handle portions 86a, 86b supporting the upper jaw element 26. The upper jaw element 26 may be formed in the same manner previously described in connection with the lower jaw element 27.

When the pair of pliers 10 is assembled, the upper and lower handle assemblies 12 and 14 are positioned with respect to one another such that a laminate stack is formed. The general nature of the laminate stack formed when the

pair of pliers is assembled as illustrated in FIG. 23. In the example of FIG. 23, a stainless steel pivot washer 135 is provided at each end of the laminate stack. An exemplary construction for such pivot washers is provided in FIGS. 24A and 24B.

The laminate stack is held together, in general, by a novel anti-impingement pin 28. In general, the anti-impingement pin 28 defines two extension members 172 that extend out from the laminate stack. To assemble the pliers, the laminate stack is formed and the extension members 172 are poined over. A detailed illustration of an exemplary anti-impingement pin 28 is provided in FIG. 25. The anti-impingement pin 28 comprises a pin having a center portion 170 and an outer portions 171. The center portion 170 has a width W1, and the center portion 170 together with outer portions 171 have a second width W2. Further, center portion 170 further has a first diameter, and outer portions 171 each have a diameter less than the diameter of center portion 170, whereby a shoulder 173 is formed on either end of the center portion 170. The width W1 is selected such that the width W1 is slightly greater than the width of the laminate stack formed by the upper handle assembly 12 and the lower jaw assembly 16. Because of this precise machining of with W1, the anti-impingement pin 28 will ensure some clearance between the laminate stack including the upper handle assembly 12 (right and left) upper handle portions 86a and 86b) and lower jaw assembly 16. As such, the anti-impingement pin 28 ensures efficient and proper assembly of the pair of pliers 10. Further, the anti-impingement pin 28 of the invention simplifies the riveting process, eliminating the need to stretch the rivet for clearance. It also enhances tool durability, eliminating unpredictable wear.

In the embodiment illustrated in FIG. 2, a biasing spring 150 is situated between the upper and lower handle assemblies 12, 14 to bias the handles 18, 22 of the pliers 10 apart. A middle portion of the biasing spring 150 is coiled around a pin 152 that extends through the pin-receiving bores 47 through the right and left side upper handle portions 34a, 34b. As shown in FIG. 2, a first outer portion of the biasing spring 150 is seated against the locking tabs 96 of the right and left side lower handle portions 86a, 86b; and a second portion of the biasing spring is seated against the upper handle spacer 36 of the upper handle assembly 12.

The general operation of the novel locking pliers 10 of the present invention will now be described. The user selects a preferred distance between the upper and lower jaws 26, 27 and presets the jaws 26, 27 through proper adjustment of the adjustment screw 30. The release slide spring 69 is heavier than the pivot release spring 68, and the release pin 222 functions as a securing member. Therefore, if the release slide 214 is not positioned such that the release pin 222 is engaged in the notch 236 (as illustrated in FIG. 2), the release slide spring 69 biases the release slide 214 to a first setting, back (towards the handles 18, 22), and against the pivot release member 212. This prevents the locking extension 118 of the connecting arm 110 from engaging and "locking" into the locking ledge 64 of the pivot release member 212. Therefore, the jaws 26, 27 will not lock during use; in other words, the lower jaw 27 is freely movable relative to the upper jaw 26. Thus, the pliers 10 operates as a spring loaded pliers. This is particularly useful, for example, if the user desires to repeatedly open and close the jaws 26, 27 to "ratchet" the pliers 10 about a work piece.

FIGS. 26A-26C show partial side views of the pliers 10, illustrating the positions of the various components of the release mechanism 21 when the pliers 10 is in locked and

unlocked positions. To lock the jaws 26, 27 about a work piece, the user first slides the actuator 210 of the release slide 214 forward (towards the jaws 26, 27) to a second setting, compressing the release slide spring 69. When the release pin 222 extending from the release button 218 reaches the notch 236, the release spring 224 will push the release button 218 up, and the release pin 222 will engage the notch 236, as shown in FIG. 26A. This locks the release mechanism in the second setting, preventing the release slide 214 from moving laterally within the cavity formed by the upper handle portions 34a, 34b and the outer and middle release spacers 230, 232. Hence, when the release pin 222 is engaged in the notch 236, the release slide 214 cannot engage the pivot release member 212.

The user then brings the upper and lower handles 18, 22 together until the locking extension 118 of the connecting arm 110 is received in and "locks" into the locking ledge 64 of the pivot release member 212. Now, the lower jaw 27 is locked at the distance preset by operation of the adjusting screw 30. Referring to FIG. 23A, once the locking extension 118 is received in the locking ledge 64, a gap 246 is formed between the lower portion 238 of the pivot release member 212 and the release slide 214, and the pivot release spring 68 biases the pivot release member 212 so as to prevent the locking ledge 64 from disengaging the locking extension 118 of the connecting arm. Thus, the pliers 10 will remain in their closed and locked position even as the user manipulates the handles 18, 22.

Referring now to FIGS. 26B and 26C, the actions required to release the pliers 10 from the closed and locked position will be described. First, the user pushes the release button 218 to disengage the release pin 222 from the notch 236. As noted above, the release slide spring 69 is heavier than the pivot release spring 68, so the release slide spring 69 pushes the release slide 214 back (towards the handles 18, 22) to a third setting. This movement of the release slide closes the gap 246 between the lower portion 238 of the release slide 214 and the pivot release member 212, and slightly compresses the pivot release spring 68.

To release the jaws 26, 27, the user then squeezes the handles 18, 22 together, thereby disengaging the locking ledge 64 from the locking extension 118. As illustrated in FIG. 26C, the release slide spring 69 fully extends, pushing the pivot release member 212 against the pivot release spring 68 and, in turn, pushing the locking ledge 64 away from the locking extension 118 to prevent the pliers 10 from unintentionally locking. Since the release slide spring 69 is heavier than the pivot release spring 68, the release slide 214 remains biased back (towards the handles 18, 22) to the first setting. For this reason, the pliers 10 will not lock, until the release slide 214 is moved to the forward position.

The present invention is not limited to the specific embodiments of the release mechanism described above. For example, it would be a routine undertaking for one skilled in the art having the benefit of this disclosure to vary the configuration of the release button 218 such that it locks the release slide at a setting other than the second setting, wherein the jaws 26, 27 will lock. Further the biasing springs 68, 69 could be reconfigured to normally bias the release mechanism to a setting other than the first setting described above, wherein the jaws 26, 27 will not lock.

As may be noted from the preceding, the connection arm 110 of the pliers 10 of the present invention remains, during the operation of the pliers, essentially within the cavity defined by the lower handle assembly 14. Moreover, there are no projections from the connection arm 110 that extend

out from the cavity defined by the lower handle assembly 14. This is in contrast to prior art locking pliers that typically include a link member that extends across the handles or that had an "extension bump" that would be contacted by another member to unlock the pliers. In the illustrated embodiment of the present invention, the connection arm 110 does not require such an "extension bump" since the locking and unlocking of the pliers is accomplished through the use of the release lever mechanism 21, which has its locking elements positioned within the cavity defined by both the upper and lower handle assemblies 12, 14. This aspect of the present invention is beneficial, among other things, because it reduces the chance that "pinch points" (points where material may be "pinched" between components of the pliers) will be formed.

A further feature of the pliers 10 of the present invention concerns the inclusion of an anti-pass center stop 48 that prevents the positioning of the pliers in an inappropriate position. FIG. 27A generally reproduces FIG. 2 without certain labels. As illustrated in FIG. 17A, the bent portions 48 of the right and left upper handle portions 34a and 34b form a stop member 48. This stop member prevents undesirable centering of the pivot points marked A, B and C in FIG. 17A.

From FIG. 27A it will be apparent that, as the adjustment screw 30 is adjusted, the pivot points A, B and C will move with respect to one another. Specifically, as the adjustment screw 30 is adjusted to move the locking portion of the connection arm 110 towards the knurled end 117 of the adjustment screw 30, the pivot release member 212 will tend to move towards the knurled end 117 of the adjustment screw 30 and the pivot pin B will tend to move towards alignment with pivot points A and C. This relative movement is generally illustrated by FIG. 27B. Also, opening and closing the pliers 10 may tend to bring the pivot points A, B and C into alignment.

As those of ordinary skill in the art will appreciate, if the pivot points A, B and C become aligned, (i.e., if B becomes centered with respect to A and C) there is a possibility that, upon the application of force, the pivot point B will not return to its original and desired position—above A and C in the example, but will tend to move towards an undesirable position (e.g., below A and C in the example). To avoid this undesirable possibility, the present invention provides the anti-pass center stop 48 that serves as a "stop" to prevent adjustment or movement of the pliers to the point where pivot point B is centered with respect to pivot points A and C. Specifically, the anti-pass center stop 48 will contact the pivot release member 212 and prevent the release arm from moving to a position where B is centered with respect to A and C.

The laminate stack configuration of the pliers 10 allows for a novel "stack" manufacturing process, which provides a simple assembly process requiring minimal tools and sub-assembly processes. The components are essentially stacked one upon another to assemble the locking pliers 10. An example of the stack assembly process for the locking pliers 10 as is illustrated in FIG. 2 follows below.

Beginning with the left side lower handle 86b, one of the outer portions 171 of the anti-impingement pin 28 extends through the bore 100 such that the shoulder 173 seats against the left side lower handle 86b. Extension members 172 extend through the bore 100 and extend out from the left side lower handle 86b. The pivot washer 135 fits over the extension member 172, which is peened over to lock the anti-impingement pin 28 in place.

The left side upper handle 34b is stacked on the left side lower handle 86b such that the cut-out section 59 seats against the anti-impingement pin 28. The lower jaw assembly 16 is stacked on top of the left side upper handle 34b such that component 70b lies adjacent the left side lower handle 86b. Further, the anti-impingement pin 28 center portion 170 extends through the large bore 72 in the lower jaw assembly 16. The upper jaw member 26 is positioned on the head portion 24 of the left side lower handle 86b.

The components of the release mechanism 21 are assembled as described above, and along with the pivot release member 212, are also stacked on the left side upper handle 34b. The rotation pin 66 extends through the bore 40 of the pivot release member 212 and the bore 46a of the left side upper handle 34b so that one end of a pin 66 terminates in the bore 46a and the pivot release member 212 pivots about the pin 66. The combination of the adjustment screw 30 coupled to the connecting arm 110 by the adjustment bracket 112 is stacked onto the left side upper handle 34b, and the rivet pin 111 extends through the adjustment bracket 112 and into the slot 98 in the left side upper handle 34b. The adjustment nut 108 is placed about the adjustment screw 30 and received by the slot 94.

The upper handle spacer 36 is stacked on the handle portion 40 of the left upper handle 34b. The pivot release spring 68 and the release slide spring 69 are positioned within their respective slots 54, 234. The pin 152 is positioned in the pin-receiving bore 47 extending through the left upper handle 34b, and the biasing spring 150 and the outer portions of the biasing spring 150 are seated against the locking tabs 96 of the left side lower handle portion 86b and the upper handle spacer 36. The right upper handle 34a is stacked on the assembly next, with the cut-out 59 seating against the anti-impingement pin 28, and pins are passed through holes 46a, 46b and 46c. Finally, the right lower handle 86a is stacked on the right upper handle 34a. The locking tabs 96 interlink to hold the handle portions 86a and 86b together. The anti-impingement pin 28 outer portion 171 extends through the bore 100 such that the shoulder 173 seats against the right side lower handle 86a, and a pivot washer 135 fits over the anti-impingement pin 28 and the extension 172 is peened. The various rivets are then put in place to secure the laminate structure together.

The novel laminate construction of the locking pliers 10 further allows for a simple and economic progressive stamping process for fabricating several of the components discussed and described herein, requiring a minimal number of die patterns.

In the embodiment disclosed in conjunction with FIG. 2, the biasing spring 150 comprises a coil spring. FIG. 28 illustrates a portion of an alternative embodiment of the pliers 10, in which the biasing spring comprises an extension spring 151 that has one end coupled to the upper jaw and the other end coupled to the lower jaw. The extension spring 151 serves to bring the pliers 10 to an open position when the pair of pliers 10 is released from its closed and locked position. The extension spring 151 also tends to retain the upper and lower jaw elements 26, 27 in a parallel or near-parallel relationship to allow for a better gripping angle. In such an embodiment, the upper and lower jaw elements include a suitable connector to which the spring connects.

Examples of suitable connectors are illustrated in FIGS. 29 and 30. In one exemplary embodiment illustrated in FIG. 29, the components 70a of the lower jaw assembly 16 defines a spring connection extension 78 that extends from

the component 76a. In FIG. 30A, an exemplary upper jaw element 26 defines a generally T-shaped slot 126. This generally T-shaped slot is designed to receive a generally T-shaped upper jaw insert 128 of the type illustrated in FIG. 30B. The T-shaped upper jaw insert 128 includes a head portion 130 and a spring connection portion 131. The extension spring 131 has one end coupled to the spring connection portion 131 of the T-shaped upper jaw insert 128 and a second end coupled to the spring connection extension 78 of lower jaw assembly 16. In yet another embodiment, rather than providing a T-shaped slot and separate jaw insert 128, the upper jaw element 26 simply includes a spring connector extending from the upper extension surface 124, proximate the T-shaped slot of the jaw element 26 illustrated in FIG. 30A.

In yet another embodiment, a leaf spring 120, such as that illustrated in FIGS. 31A and 31B, provides a biasing force tending to bias the connection arm 110 upwards (towards the upper handle assembly 12). The leaf spring 120 may be formed from spring steel and may be coupled via rivets to one, or both, of the right and left side lower handle portion 86a, 86b. In addition to tending to bias the connection arm 110 to a bias position, the leaf spring 120 also tends to maintain the pliers 10 in their closed and locked position when the pliers are placed in their closed and locked position because the leaf spring 120 will tend to bias the connecting arm 110 such that it remains in a "locked" relationship with the locking portion of the pivot release member 212. Further, when the release lever 21 is depressed and the connection arm 110 is disengaged from the release lever 21, the spring 120 will tend to force the pliers to their open position. The use of such a leaf spring 120 does not require any modification of connection arm 110 to accommodate the existence of the leaf spring 120 within the cavity defined by the lower handle assembly 14. The leaf spring 120 may simply be riveted to one of the L-shaped locking tabs 96.

Further, the configurations of the upper and lower jaw elements 26 and 27 may be different from those illustrated above. In particular, V-notched, straight and curved jaw configurations are envisioned. Still further, in the illustrative embodiment described above, the actuator 210 of the release mechanism 21 extends from the top of the upper handle assembly 12. Likewise, in the embodiment described above employing the pivot release member 213 illustrated in FIG. 10, the top portion of the release member 213 extends from the top of the upper handle assembly 12. Other embodiments, such as the one illustrated in FIG. 32, are envisioned wherein the upper handle portion 12 includes side slots 313 and a lever 314 or other suitable mechanism extends sideways from the upper handle assembly such that the side lever may be activated to unlock the pliers 10. In such an embodiment, the side lever may be adjustable for left-handed or right-handed operation. In such an embodiment the top portion of the release lever 213 may be eliminated entirely or retained.

A still further embodiment involves the construction of the upper handle assembly 12. As discussed above, the upper handle assembly 12 is sized such that, as the pliers 10 are opened and closed, there is little or no gap created between the upper handle assembly 12 and the lower handle assembly 14. Alternative embodiments are envisioned where such a gap is intentionally introduced and is controlled to form wire cutters and/or wire strippers. Such an alternate embodiment is generally illustrated in FIG. 20 where the upper handle assembly is sized such that a controlled gap 250 can be established through proper adjustment of the adjustment screw 30. In the illustrative embodiment the gap 250 defines several wire strippers 252 of several sizes and a wire cutter 254.

While the invention has been described in connection with the illustrative embodiments discussed above, those skilled in the art will recognize that many variations may be made without departing from the present invention. For example, the components of the locking pliers disclosed herein may be formed from different materials than described herein. Accordingly, the above description of several embodiments is made by way of example and not for purposes of limitation. The present invention is intended to be limited only by the spirit and scope of the following claims.

- What is claimed is:
1. A pair of locking pliers comprising:
 - a first assembly defining a first handle and a first jaw, the first handle defining a cavity therein;
 - a second handle;
 - a second jaw pivotably coupled to the first assembly and the second handle, such that the second handle is movable relative to the first handle to move the second jaw relative to the first jaw;
 - a locking mechanism interconnecting the first assembly and the second handle, the locking mechanism including a locking arm defining a locking extension, the locking arm and locking extension being situated within the cavity of the first handle; and
 - a release mechanism pivotably coupled to the second handle, the release member defining a locking ledge formed for selective engagement with the locking extension of the locking arm for locking the second jaw at a predetermined distance from the first jaw.
2. The locking pliers of claim 1 wherein the first jaw is fixed relative to the first handle.
3. The locking pliers of claim 1 wherein the locking mechanism includes an adjustment mechanism for setting the distance between the second jaw and the first jaw when the locking extension of the locking arm is engaged with the locking ledge of the release mechanism.
4. The locking pliers of claim 3 wherein the adjustment mechanism comprises:
 - an adjustment screw having a first end connected to the locking arm; and
 - a nut fixed within the cavity, the adjustment screw threadably engaged in the nut such that turning the adjustment screw moves the locking arm laterally within the cavity.
5. The locking pliers of claim 4 wherein the first assembly includes two walls defining two sides of the cavity, each of the walls defining an opening extending therethrough, each of the openings adapted to receive a portion of the nut, such that the nut is held within the openings to fix the nut within the cavity.
6. The locking pliers of claim 4 wherein the locking arm defines first and second ends, and wherein:
 - the second handle is connected to the second jaw at a first pivot point;
 - the first end of the locking arm is connected to the second handle at a second pivot point;
 - the first end of the adjustment screw is connected to the second end of the locking arm at a third pivot point; and
 - the second handle includes a stop adapted to prevent the first, second and third pivot points from aligning.
7. The locking pliers of claim 1 wherein the release mechanism comprises a release lever having first and second ends, the first end defining the locking ledge, the second end movable to pivot the release lever to one of a first position wherein the locking ledge engages the locking extension of

the locking arm when the second handle is moved towards the first handle, and a second position wherein the locking ledge disengages the locking extension of the locking arm.

8. The locking pliers of claim **6** wherein the release mechanism further comprises an actuator movably mounted to the second handle, the actuator interacting with the second end of the release lever to pivot the release lever to one of the first and second positions.

9. The locking pliers of claim **8** wherein the second handle defines a cavity therein, and wherein the release lever is situated within the cavity in the second handle.

10. The locking pliers of claim **1** further comprising an anti-impingement pin including a generally cylindrical center portion defining a first diameter and a width, two generally cylindrical outer portions extending coaxially from either side of the center portion, the outer portions each defining a second diameter that is less than the first diameter, and two extension members extending coaxially from either outer portion, wherein:

the first assembly, the second handle and the second jaw are each of a laminated construction, each comprising two substantially flat pieces, each piece defining a width;

the second jaw pieces being situated adjacent each other and defining a bore extending therethrough, the bore adapted to receive the center portion of the anti-impingement pin such that the second jaw pivots about the center portion;

the second handle pieces being situated on either side of the second jaw pieces;

the first assembly pieces each defining a bore extending therethrough, each bore adapted to receive one of the outer portions of the anti-impingement pins such that the first assembly pivots about the outer portions;

the width of the center portion of the anti-impingement pin being greater than the sum of the widths of the second jaw and second handle pieces; and

each of the extension members has a securing member affixed thereto.

11. The locking pliers of claim **1** further comprising a biasing member adapted to normally bias the second handle away from the first handle.

12. The locking pliers of claim **11** wherein the biasing member comprises a coil spring having first and second ends and an intermediate portion between the first and second ends, the first end coupled to the first handle, the second end coupled to the second handle, the intermediate portion coiled around a pin fixed to the first assembly, wherein the coil spring biases the second handle apart from the first handle.

13. The locking pliers of claim **11** wherein the biasing member comprises an extension spring coupled between the first and second jaws so as to pull the jaws apart.

14. A pair of locking pliers comprising:
a first assembly defining a first handle and a first jaw;
a second handle;
a second jaw pivotably coupled to the first assembly and the second handle, such that the second handle is movable relative to the first handle to move the second jaw relative to the first jaw;
a release mechanism having a first setting wherein the second jaw is freely movable relative to the first jaw, a second setting wherein the second jaw locks at a preset distance from the first jaw when the second handle is moved toward the first handle, and a third setting

wherein the second jaw unlocks when the second handle is moved toward the first handle; and
a biasing member adapted to normally bias the release mechanism to the first setting.

15. The locking pliers of claim **14** wherein the release mechanism further includes a securing device adapted to selectively lock the release mechanism in the second setting.

16. The locking pliers of claim **14** further comprising a locking arm defining a locking extension, and wherein the release mechanism comprises:

a pivot member rotatably coupled to the second handle, the pivot member having first and second ends, the first end defining a locking ledge adapted to engage the locking extension to lock the second jaw relative to the first jaw; and
a release slide movably mounted to the first assembly, the release slide situated to interact with the second end of the pivot member to selectively engage and disengage the locking ledge and locking extension.

17. The locking pliers of claim **16** wherein the second handle defines a notch, and wherein the release slide defines an opening therein adapted to receive a release button, the release button including a pin extending therefrom adapted to seat within the notch to lock the release slide in a predetermined position.

18. The locking pliers of claim **16** wherein the second handle defines a cavity therein, and wherein the pivot member and at least a portion of the release slide are positioned within the cavity.

19. A pair of locking pliers comprising:

an upper handle assembly, the upper handle assembly defining an upper handle and an upper handle cavity;
a release lever pivotably mounted in the upper handle cavity, the release lever defining a locking ledge;

a lower handle assembly, the lower handle assembly defining a lower handle, a lower handle assembly cavity, and an upper head portion;

an upper jaw element positioned within the upper head portion;

a lower jaw assembly including a lower jaw element, the lower jaw assembly being pivotably coupled to the upper handle assembly; and

an adjustment mechanism positioned within the lower handle assembly cavity, the adjustment mechanism being coupled to the upper handle assembly and including a connection arm defining a locking end that is formed for selective engagement with the locking ledge of the release lever, wherein adjustment of the adjustment assembly adjusts the distance between the upper jaw element and the lower jaw element when the locking end of the connection arm is engaged with the locking ledge of the release lever.

20. The locking pliers of claim **19** wherein the upper handle assembly, the lower handle assembly, and a lower jaw assembly are formed from substantially flat components, the flat components stacked together to form a laminate stack.

- 21.** A pair of locking pliers comprising:
 a first handle defining a handle portion and a jaw portion;
 a second handle;
 a second jaw pivotably coupled to the second handle such
 that the second handle is movable relative to the first
 handle portion;
 first means for pivotably coupling the second jaw to the
 first handle; and
 second means for locking and releasing the first and
 second jaws relative to each other, including means
 for selectively setting the second means at a first
 setting wherein the second jaw is freely movable
 relative to the first jaw, a second setting wherein the
 second jaw locks at a preset distance from the first
 jaw when the second handle is moved toward the
 first handle, and a third setting wherein the second
 jaw unlocks when the second handle is moved
 toward the first handle.
22. The locking pliers of claim 21 further comprising third
 means for presetting the second jaw at a desired distance
 from the first jaw when the jaws are locked.
23. The locking pliers of claim 21 wherein the second
 means includes means for selectively setting the second
 means at a first setting wherein the second jaw is freely
 movable relative to the first jaw, a second setting wherein the
 second jaw locks at a preset distance from the first jaw when
 the second handle is moved toward the first handle, and a
 third setting wherein the second jaw unlocks when the
 second handle is moved toward the first handle.
24. The locking pliers of claim 21 further comprising
 means for biasing the first and second handles normally
 apart.
25. A pair of locking pliers comprising:
 a first assembly defining a first handle and a first jaw;
 a second handle;

- a second jaw pivotably coupled to the first assembly and
 the second handle, such that the second handle is
 movable relative to the first handle to move the second
 jaw relative to the first jaw;
 a locking arm defining a locking extension; and
 a release mechanism including:
 a pivot member pivotably coupled to the second
 handle, the pivot member having first and second
 ends, the first end defining a locking ledge adapted to
 engage the locking extension to lock the second jaw
 relative to the first jaw; and
 a release slide movably mounted to the first assembly,
 the release slide situated to interact with the second
 end of the pivot member to selectively engage and
 disengage the locking ledge and locking extension;
 wherein the release mechanism has a first setting wherein
 the second jaw is freely movable relative to the first
 jaw, a second setting wherein the second jaw locks at
 a preset distance from the first jaw when the second
 handle is moved toward the first handle, and a third
 setting wherein the second jaw unlocks when the
 second handle is moved toward the first handle.
26. A pair of locking pliers comprising:
 a first handle defining a handle portion and a jaw portion;
 a second handle;
 a second jaw pivotably coupled to the second handle such
 that the second handle is movable relative to the first
 handle portion;
 first means for pivotably coupling the second jaw to the
 first handle;
 second means for locking and releasing the first and
 second jaws relative to each other; and
 third means for biasing the first and second handles
 normally apart.

* * * * *

Appendix D. Patent for a telescoping leg



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(12) **Patent Application Publication**
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(43) **Pub. Date: Oct. 8, 2009**

(54) **TELESCOPING LEG LOCK AND PORTABLE
ELEVATED PLATFORM WITH SAME**

(52) **U.S. CL** 248/188.5; 248/188.8

(76) Inventor: **David J. Laws, Provo, UT (US)**

(57) **ABSTRACT**

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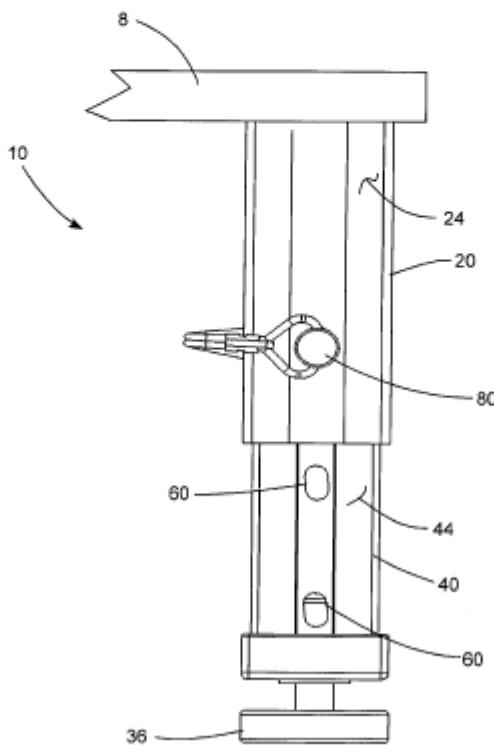
(21) Appl. No.: **12/098,955**

(22) Filed: **Apr. 7, 2008**

Publication Classification

(51) Int. Cl.
F16M 11/26 (2006.01)

A telescoping leg for supporting an elevated platform includes an outer leg. An inner leg is slidably disposed within the outer leg. An off-axis slot is disposed through a sidewall of one of either the inner leg or the outer leg and an aperture is disposed in the other. The inner leg is slidably positionable within the outer leg to align the off-axis slot with the aperture. A pin is disposable through the aperture and the slot when the aperture and the slot are aligned such that a bearing surface of the pin contacts a bearing surface of the slot to laterally push the inner leg against the outer leg.



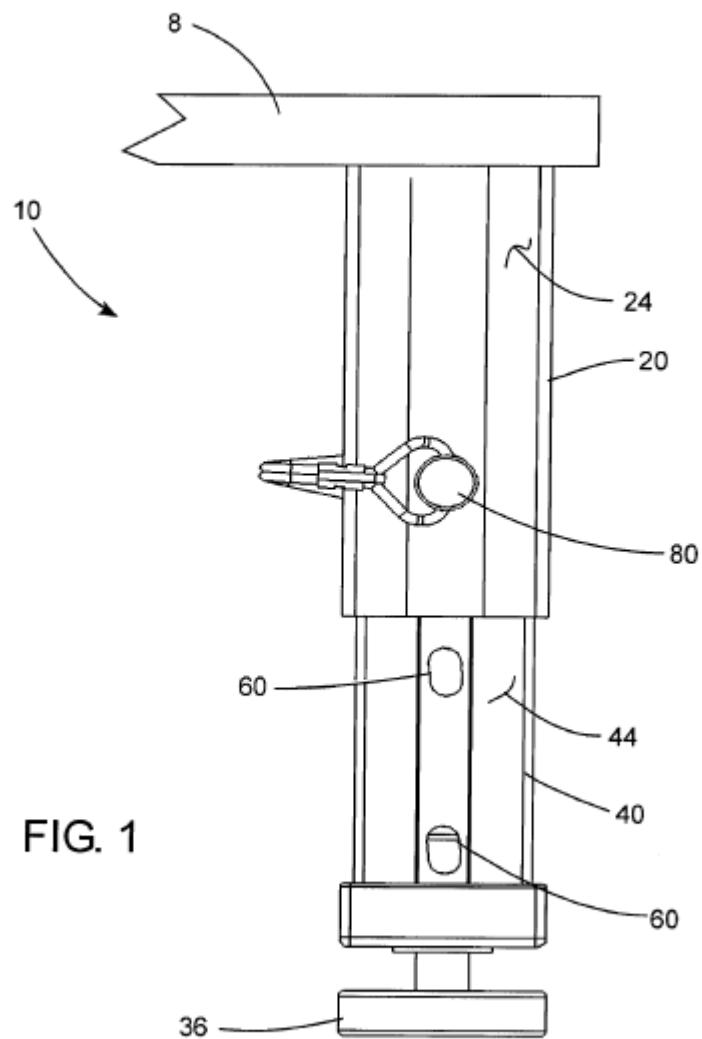


FIG. 1

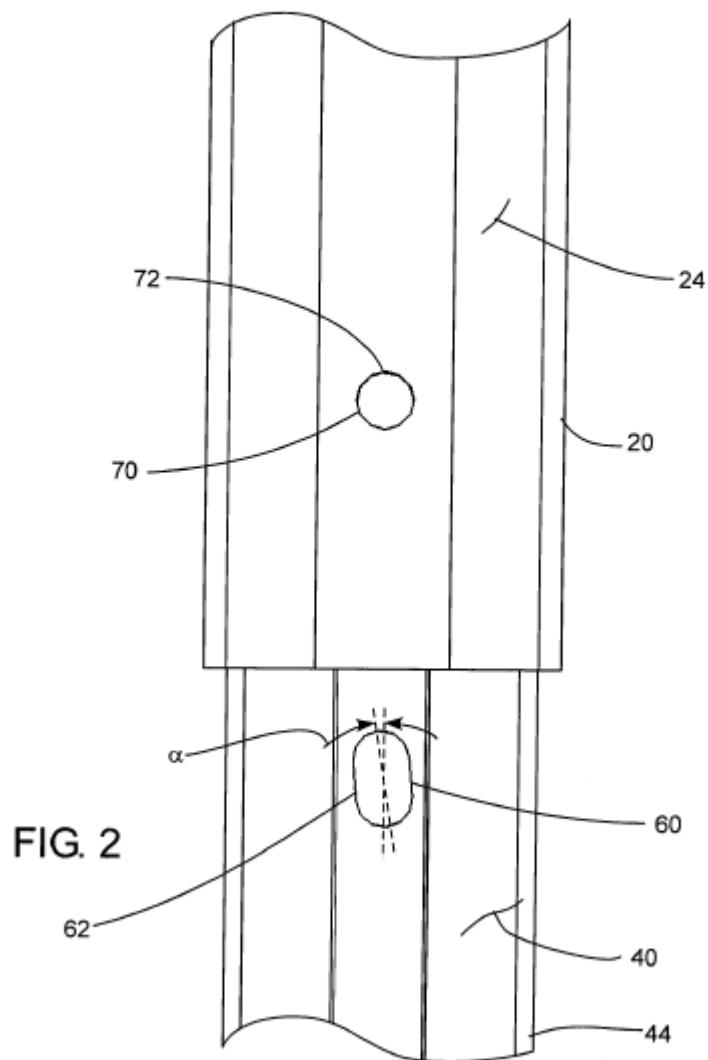
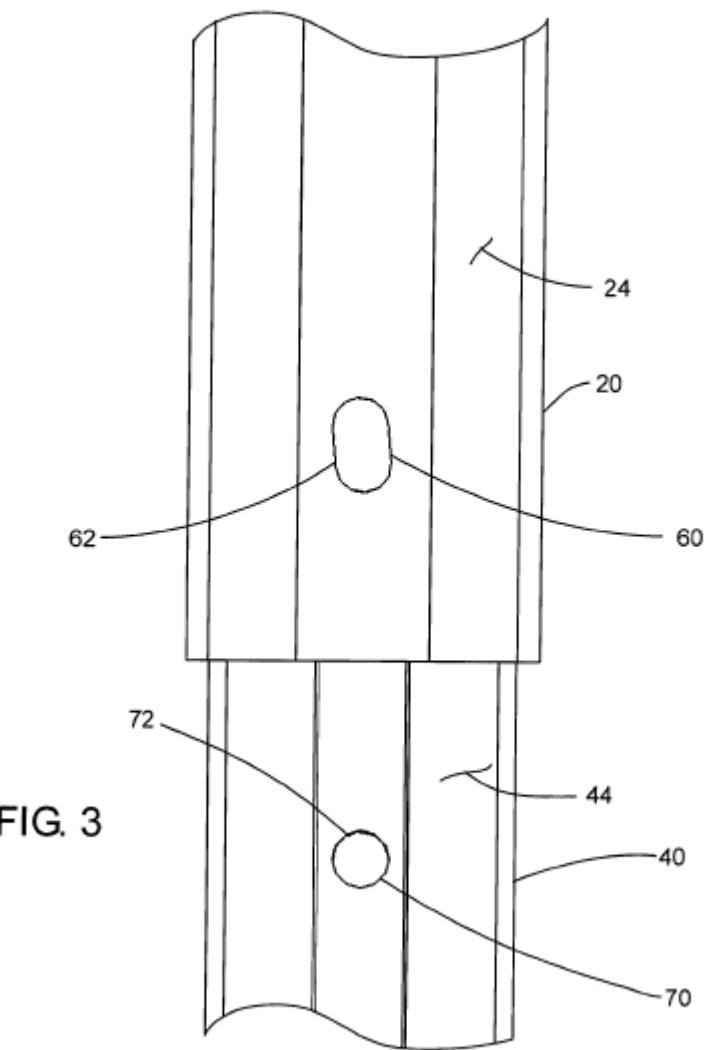


FIG. 2



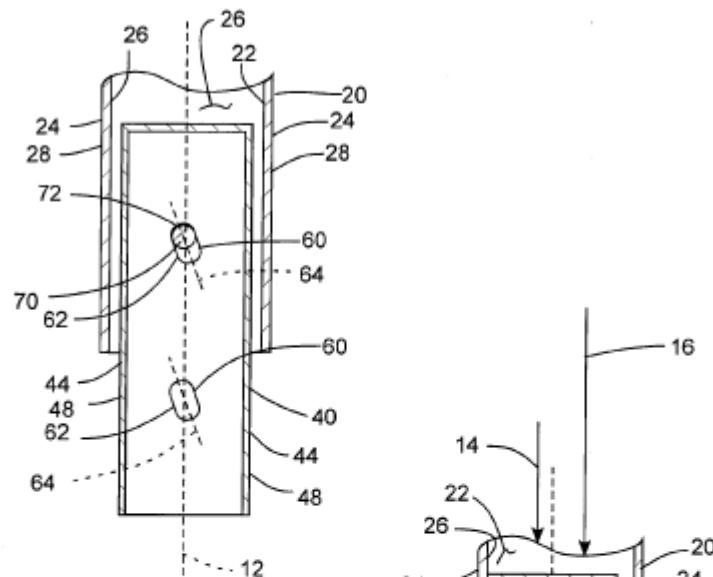


FIG. 4

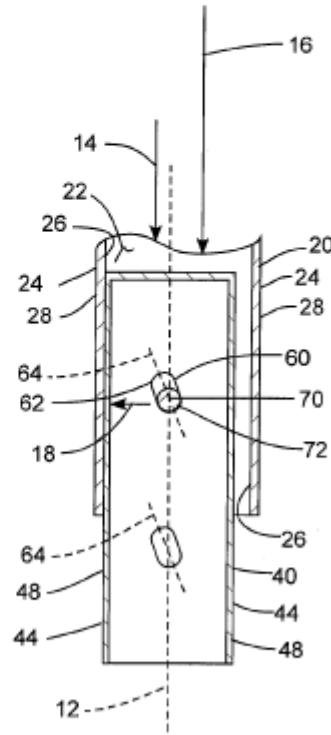
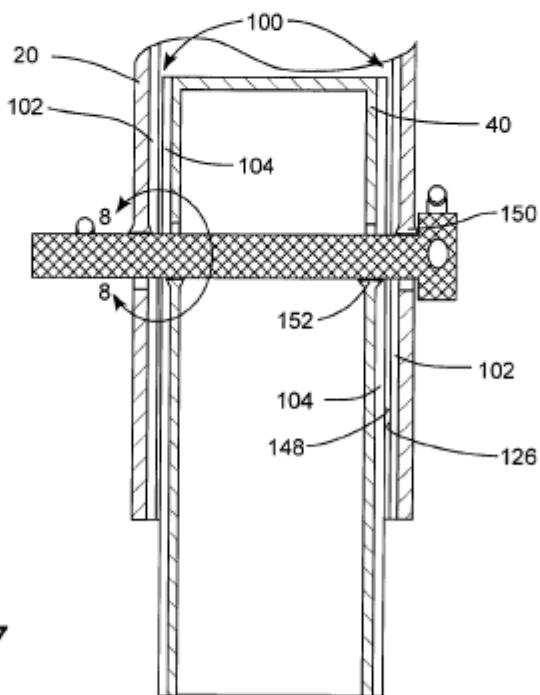
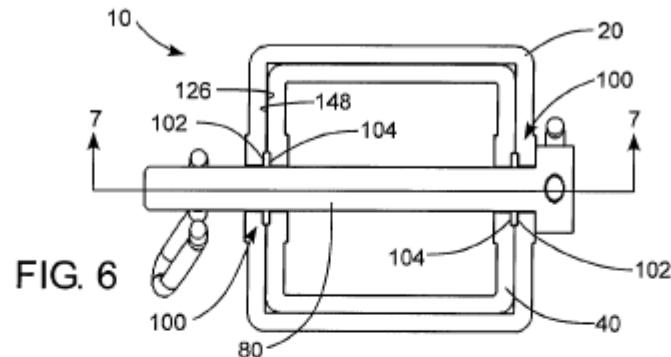


FIG. 5



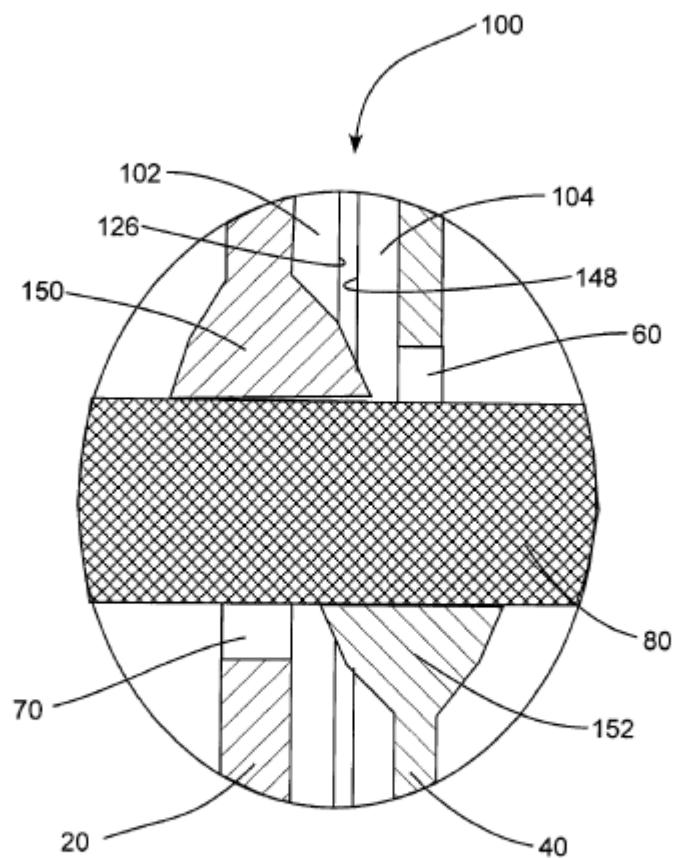


FIG. 8

**TELESCOPING LEG LOCK AND PORTABLE
ELEVATED PLATFORM WITH SAME**

RELATED APPLICATIONS

[0001] This application related to U.S. patent application Ser. No. _____, filed Apr. 7, 2008, entitled "Portable Elevated Platform with Locking Legs" as TNW Docket Number 00538-32685; and U.S. patent application Ser. No. _____, filed Apr. 7, 2008, entitled "Portable Elevated Platform" as TNW Docket Number 00051-32686; which are herein incorporated by reference in their entirety for all purposes.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to telescoping legs for portable elevated platforms such as stages, risers, tables, chairs, scaffolding, and the like.

[0004] 2. Related Art

[0005] Many portable elevated platforms such as portable stages, risers, tables, chairs, scaffolding and the like have extendible legs that can be adjusted to place the platform at a variety of heights. Such legs are often telescoping legs with an inner leg slidably disposed within a hollow outer leg. The inner leg can slide within the outer leg to lengthen the leg. Thus, when a higher platform is desired, the inner leg can be slid out of the outer leg and locked into place. Similarly, when an inner platform is desired, the inner leg can be slid into the outer leg and locked into place.

[0006] One type of locking device for such legs includes a pin that can slide through holes in the inner and outer legs. To lock the leg, the holes in the inner leg are aligned with the holes in the outer leg and the pin is slid through the holes to prevent movement of the inner leg with respect to the outer leg.

[0007] It will be appreciated that in order for the inner leg to slide within the outer leg, the inner leg must have a smaller cross sectional area than the outer leg. Often, this cross sectional area difference is large enough that the inner leg can move laterally inside the outer leg in addition to sliding longitudinally within the outer leg. Unfortunately, the pin lock described above, while adequate at restricting sliding movement of the inner leg with respect to the outer leg, usually does not prevent lateral movement of the inner leg inside the outer leg. Consequently, the legs can shift slightly when the platform is loaded, or the load on the platform moves. This shifting can cause creaking and rattling of the portable platform. Additionally, lateral shifting of the inner leg can cause an unsteady feeling to people standing on the platform because the platform is moving.

[0008] Another type of locking device for telescoping legs includes a threaded set screw that extends through the outer leg and pushes the inner leg against the outer leg so as to clamp the inner leg into place. Unfortunately, such set screws or other similar threaded fasteners are time consuming to properly engage because they have to be rotated until the set screw engages the inner leg with sufficient force to hold the inner and outer legs in position when a load is placed on the leg. Additionally, dynamic loading on the leg, or increasing the weight of the load can sometimes cause the set screw to slip along the inner leg which can result in a collapse or partial

collapse of the leg during use. Moreover, this loading can move the inner leg and make relative sliding between the legs increasingly difficult.

SUMMARY OF THE INVENTION

[0009] The inventors of the present invention have recognized that it would be advantageous to develop an extendible leg for an elevated platform with reduced noise. Additionally, the inventors of the present invention have recognized that it would be advantageous to develop a method and device for locking a telescoping leg at a predetermined height and to increase stability and reduce shifting of the legs.

[0010] The invention provides a telescoping leg for supporting an elevated platform including an outer leg coupled to the elevated platform. An inner leg can be slidably disposed with respect to the outer leg. At least one off-axis slot can be disposed through a sidewall of one of either the inner leg or the outer leg and an aperture can be disposed in the other one of the inner leg or outer leg. The inner leg can be slidably positionable with respect to the outer leg to align the at least one off-axis slot with the at least one aperture. A pin can be disposed through the at least one aperture and the at least one off-axis slot when the aperture and the slot are aligned such that a bearing surface of the pin can contact a bearing surface of the at least one off-axis slot to laterally push the outer leg against the outer leg.

[0011] The present invention also provides for a method for reducing movement and noise of a telescoping leg for an elevated platform when a load is placed on the raised platform. The method can include sliding an inner leg with respect to an outer leg to a desired length. An aperture in one of the inner leg or the outer leg can be aligned with an off-axis slot in the other of the inner leg or outer leg. A pin can be placed through the aperture and off-axis slot. An applied load can be placed on the telescoping leg such that a bearing surface of the pin can contact a bearing surface of the off-axis slot. The force of the pin against the bearing surface of the off-axis slot can push the inner leg against the outer leg to reduce movement of the inner leg with respect to the outer leg.

[0012] Additional features and advantages of the invention will be apparent from the detailed description which follows, taken in conjunction with the accompanying drawings, which together illustrate, by way of example, features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a side view of a telescoping leg in accordance with an embodiment of the present invention;

[0014] FIG. 2 is a fragmentary side view of the telescoping leg of FIG. 1 with an off-axis slot disposed in an inner leg;

[0015] FIG. 3 is a fragmentary side view of the telescoping leg of FIG. 1 with an off-axis slot disposed in an outer leg;

[0016] FIG. 4 is a fragmentary cross section view of the telescoping leg of FIG. 1, shown in an unloaded configuration;

[0017] FIG. 5 is a fragmentary cross section view of the telescoping leg of FIG. 1, shown in a loaded configuration;

[0018] FIG. 6 is a top cross sectional view of the telescoping leg of FIG. 1, showing a burr groove in the inner and outer legs;

[0019] FIG. 7 is a longitudinal cross sectional view of the telescoping leg of FIG. 1, showing the burr groove extending longitudinally along the inner and outer legs; and

[0020] FIG. 8 is a fragmentary longitudinal cross sectional view of the telescoping leg of FIG. 1, showing the burr groove extending longitudinally along the inner and outer legs.

DETAILED DESCRIPTION

[0021] Reference will now be made to the exemplary embodiments illustrated in the drawings, and specific language will be used herein to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Alterations and further modifications of the inventive features illustrated herein, and additional applications of the principles of the inventions as illustrated herein, which would occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the invention.

[0022] The embodiments of the present invention described herein provide generally for an extendible leg for a portable elevated platform such as a portable stage, riser, scaffolding, and the like. The extendible leg can be a telescoping leg having an inner leg slidably associated with a hollow outer leg. In one aspect, the inner leg can slide out of the outer leg to make the leg longer. Similarly, the inner leg can slide into the outer leg to make the leg shorter. The outer leg can be coupled to the elevated platform. An off axis slot can be disposed in a side wall of either the outer leg or the inner leg. The off axis slot can have a longitudinal axis that is skew at a predetermined angle α with respect to a longitudinal axis of the leg. An aperture can be disposed in the other of the outer or the inner leg. The off-axis slot and the aperture can be aligned by sliding the inner leg into or out of the outer leg. A pin can be placed through the aligned off-axis slot and the aperture to restrict the inner leg from sliding within the outer leg. A bearing surface of the pin can rest against a bearing surface of the off-axis slot so that when a load is placed on the elevated platform, the weight of the load and the platform can push the bearing surface of the pin along the bearing surface of the off-axis slot so that the pin moves along the axis of the off-axis slot. In this way, the pin can move the inner leg laterally within the outer leg until the inner leg is wedged against an inner sidewall of the outer leg. Additionally, the pin and the off axis slot can restrict further lateral movement of the inner leg with respect to the outer leg in order to reduce noise and movement from the telescoping leg.

[0023] As illustrated in FIGS. 1-4, a telescoping leg, indicated generally at 10, in accordance an embodiment of the present invention shown for use in supporting a portable elevated platform 8 such as a portable stage, riser, scaffold, and the like. As used herein, the term portable elevated platform means any type of platform used for supporting standing or walking people. For example, a portable elevated platform can be a performance stage, a dance stage, choral risers, baker scaffolding, scaffolding, and the like.

[0024] The telescoping leg 10 can include an outer leg 20 and an inner leg 40. In one aspect, the outer leg can be a hollow shaft forming an outer, hollow outer leg. Similarly, the inner leg can be an inner shaft slidably disposed within the outer, hollow outer leg. The leg 10 can also have a foot 36.

[0025] The outer leg 20 can be coupled to the portable elevated platform 8. The outer leg 20 can be formed of suitable structural material such as metal, structural polymers, composite materials, and the like. The outer leg 20 can have a hollow interior space 22 (FIG. 4) and at least one sidewall 24 substantially circumscribing and enclosing the hollow interior space 22. In one aspect, the outer leg 20 can be quadrangular in shape having 4 connected sidewalls 24. The sidewalls 24 of the outer leg 20 can have an internal surface 26 and an external surface 28, as best seen in FIG. 4. It will be appreciated that the outer leg can have different configurations, such as C-channels, square tubes, circular tubes, angle stock, and the like.

[0026] Referring again to FIGS. 1-4, the inner leg 40 can be slidably disposed within the hollow interior space 22 of the hollow outer leg 20. The inner leg 40 can also be formed of a suitable structural material such as metal, structural polymers, composite materials, and the like. Similar to the outer leg, it will be appreciated that the inner leg can have different configurations, such as C-channels, square tubes, circular tubes, angle stock, and the like.

[0027] In one aspect, the inner leg 40 can be similarly shaped as the outer leg 20. Thus, in the case where the outer leg 20 is quadrangular having four connected sidewalls 24, the inner leg 40 can also be quadrangular having 4 connected sidewalls 44. The sidewalls 44 of the inner leg 40 can have external surfaces 48 of the inner leg 40 can slide and rest against the internal surfaces 26 of the sidewalls 24 of the outer leg 20.

[0028] At least one off-axis slot 60 can be disposed through a sidewall 24 or 44 of one of either the inner leg 40 or the outer leg 20. In one aspect, the off-axis slot 60 can be disposed in the inner leg 40, as shown in FIGS. 1-2. In another aspect, the off-axis slot 60 can be disposed in the outer leg 20, as shown in FIG. 3. In either case, the off-axis slot can be oriented skew at a predetermined angle α to a longitudinal axis of the legs.

[0029] The off-axis slot 60 can have a bearing surface 62 and a longitudinal axis, indicated by dashed lines at 64. The longitudinal axis 64 of the off-axis slot 60 can be oriented at an acute angle with respect to a longitudinal axis, indicated by dashed lines at 12 of the telescoping leg 10. In one aspect, the longitudinal axis 64 of the off-axis slot 60 can be rotated at an angle of about 1 to 5 degrees with respect to the longitudinal axis 12 of the telescoping leg 10.

[0030] An aperture 70 can be disposed in a corresponding sidewall 24 or 44 in the other one of the inner leg 40 or the outer leg 20. Thus, in one aspect, the aperture 70 can be disposed in the outer leg 20, as shown in FIGS. 1-2, and, in another aspect, the aperture 70 can be disposed in the inner leg 40, as shown in FIG. 1.

[0031] In one embodiment, the aperture 70 can be a substantially circular hole that extends through the sidewall 24 or 44 of the inner leg or the outer leg. The aperture or hole 70 can have a bearing surface 72. The inner leg 40 can be slid within the outer leg 20 to align the off-axis slot 60 with the least one aperture 70. For purposes of this application, the term "pin" is used broadly and can include any member disposed through the aperture and the slot, such as a rod, detent, spring pin, bolt, screw, and the like.

[0032] A pin 80 can be disposed through the aperture 70 and the off-axis slot 60 when the aperture and the slot are aligned. The pin 80 can be a cotter pin, a bearing pin, a shear pin, a spring pin, or the like. The pin 80 can have a bearing surface 82 that can contact and bear on the bearing surface 62 of the off-axis slot 60 and the bearing surface 72 of the aperture 70.

[0033] Referring to FIGS. 4-5, in use, an aperture 70 can be aligned with an off-axis slot 60 and a pin 80 can be placed through the aperture and the off-axis slot, as shown in FIG. 4. As seen in FIG. 5, when the leg 10 is supporting the platform,

the weight of the platform, indicated by the arrow at 14, can press the bearing surface 72 of the aperture 70 downward on the bearing surface 82 of the pin 80. Similarly, when a load, indicated by the arrow at 16, is placed on the elevated platform, the weight of the load and the weight of the platform can push the bearing surface 72 of the aperture 70 downward on the bearing surface 82 of the pin 80. With the pin 80 being pushed downward, the bearing surface 82 of the pin 80 can contact and push downward along the bearing surface 62 of the off-axis slot 60. Because the longitudinal axis 64 of the slot 60 is at an angle with respect to the longitudinal axis 12 of the leg 10, at least a portion of the downward force exerted by the bearing surface 82 of the pin 80 on the bearing surface 62 of the slot 60 is translated to a substantially horizontal or lateral force, indicated generally by an arrow at 18, on the inner leg 40. This lateral force 18 can move the inner leg 40 laterally within the outer leg 20 until the external surface 48 of the sidewall 44 of the inner leg 40 is wedged against the internal surface 26 of a corresponding sidewall 24 of the outer leg 20. In this way, the pin 80 and the off-axis slot 60 can restrict lateral movement of the inner leg 40 with respect to the outer leg 20, and, thus, reduce movement and noise in the telescoping leg 10.

[0034] The telescoping leg 10 of the present invention has several particular advantages. For example, as discussed above, the wedging action of the off-axis slot and pin force the inner leg against the outer leg and reduce racking noise and movement. Additionally, the pin can be quickly inserted through the aligned off-axis slot and aperture to allow efficient and timely set up of the telescoping legs, as opposed to the relatively time consuming rotation of a threaded type fastener or set screw.

[0035] Turning to FIGS. 6-8, the telescoping leg can also have a burr groove, indicated generally at 100. The burr groove 100 can be formed by a channel 102 extending longitudinally along an inner wall 126 of the outer leg 20 and a mating channel 104 extending longitudinally along an outer wall 148 of the inner leg 40. The outer wall 148 of the inner leg 40 can correspond to the inner wall 126 of the outer leg 20. The channel 102 in the outer leg 20 can be positioned adjacent the mating channel 104 in the inner leg 40. In this way, the channel 102 in the inner wall 126 of the outer leg 20 can align with the mating channel 104 in the outer wall 148 of the inner leg 40 in order to form the burr groove 100 between the outer leg and inner leg. The channels 102 and 104, or burr groove 100, can be aligned with the slot 60.

[0036] Advantageously, the burr groove 100 can reduce the likelihood of binding between the inner leg 40 and the outer leg 20. It will be appreciated that the inner and outer legs can be formed of a relatively light weight but soft metal such as aluminum. When the telescoping leg 10 is set at a desired height, and the pin 80 is placed through the aperture 70 and the slot 60 in the telescoping leg 10, the weight of the platform 8 and any additional loading placed on the platform, such as from people walking on the platform, can be transferred to the interface between the pin 80 and the aperture 70 and slot 60 in the inner leg 40 and the outer leg 20.

[0037] Because this loading can exceed the strength of the aluminum, a burr 150 can form in the outer leg 20 and another burr 152 can form on the inner leg 40, as seen in FIGS. 7-8. The burrs 150 and 152 can protrude away from the sidewall 126 of the outer leg 20 and the sidewall 148 of the inner leg 40. When these burrs 150 and 152 form between the inner and outer legs, the burrs can bind the inner leg 40 against the outer

leg 20 causing the inner leg to be difficult to move relative to the outer leg. Thus, the burr groove 100 can be sized and shaped to create a passageway for the burrs 150 and 152 in order to allow the burrs to move without contacting the mating leg when the telescoping leg extended or retracted.

[0038] The present invention also provides for a method for reducing movement and noise of a telescoping leg for an elevated platform when a load is placed on the raised platform. The method can include sliding an inner leg within an outer leg to a desired length. An aperture in one of the inner leg or the outer leg can be aligned with an off-axis slot in the other of the inner leg or outer leg. A pin can be placed through the aligned aperture and off-axis slot. An applied load can be placed on the telescoping leg such that a bearing surface of the pin can contact a bearing surface of the off-axis slot. The force of the pin against the bearing surface of the off-axis slot can push the inner leg against the outer leg to reduce movement of the inner leg with respect to the outer leg.

[0039] The method can also include removing the pin from the aligned aperture and off-axis slot. The aperture can be aligned with a different off-axis slot to change the length of the telescoping leg. The pin can be placed through the aligned aperture and the different off-axis slot.

[0040] The method can also include supporting a portable elevated platform with the telescoping leg.

[0041] It is to be understood that the above-referenced arrangements are only illustrative of the application for the principles of the present invention. Numerous modifications and alternative arrangements can be devised without departing from the spirit and scope of the present invention. While the present invention has been shown in the drawings and fully described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiment(s) of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications can be made without departing from the principles and concepts of the invention as set forth herein.

What is claimed is:

1. A telescoping leg for supporting an elevated platform, comprising:
 - a) an inner leg couplable to the elevated platform;
 - b) an inner leg slidably disposed with respect to the outer leg;
 - c) at least one off-axis slot disposed through a sidewall of one of either the inner leg or the outer leg and corresponding to at least one aperture in the other one of the inner leg or outer leg, the inner leg being slidable with respect to the outer leg to align the at least one off-axis slot with the at least one aperture, the off-axis slot oriented askew to a longitudinal axis of the legs; and
 - d) a pin disposable through the at least one aperture and the at least one off-axis slot when the aperture and the slot are aligned.
2. A leg in accordance with claim 1, wherein a bearing surface of the pin contacts a bearing surface of the at least one off-axis slot to push the inner leg against the outer leg.
3. A leg in accordance with claim 1, wherein the at least one off-axis slot is disposed in a sidewall of the inner leg and the at least one aperture is disposed in a sidewall of the outer leg.
4. A leg in accordance with claim 1, wherein the at least one off-axis slot is disposed in a sidewall of the outer leg and the at least one aperture is disposed in a sidewall of the inner leg.

5. A leg in accordance with claim 1, wherein a longitudinal axis of the slot is oriented at an acute angle with respect to the longitudinal axis of the legs.

6. A leg in accordance with claim 1, wherein a longitudinal axis of the slot is oriented at an angle of about 1 to 5 degrees with respect to a longitudinal axis of the legs.

7. A leg in accordance with claim 1, wherein an elevated platform is couplable to the outer leg.

8. A leg in accordance with claim 1, further comprising:

- a) a channel extending longitudinally along an inner wall of the outer leg;

- b) a mating channel extending longitudinally along an outer wall of the inner leg, the outer wall of the inner leg corresponding to the inner wall of the outer leg; and
- c) the channel in the inner wall of the outer leg being aligned with the mating channel in the outer wall of the inner leg to form a burr groove between the outer leg and inner leg.

9. A telescoping leg for supporting an elevated platform, comprising:

- a) an outer leg couplable to the elevated platform and having at least one aperture through a sidewall;
- b) an inner leg slidably disposed within the outer leg;
- c) at least one off-axis slot disposed through a sidewall of the inner leg, the inner leg being slidably positionable within the outer leg to align the at least one off-axis slot in the inner leg with the at least one aperture in the outer leg; and
- d) a pin disposable through the at least one aperture in the outer leg and the at least one slot in the inner leg when the aperture and the slot are aligned such that a bearing surface of the pin contacts a bearing surface of the at least one slot to laterally push the inner leg against the outer leg.

10. A leg in accordance with claim 9, wherein a longitudinal axis of the slot is oriented at an acute angle with respect to a longitudinal axis of the legs.

11. A leg in accordance with claim 9, wherein a longitudinal axis of the slot is oriented at an angle of about 1-5 degrees with respect to a longitudinal axis of the legs.

12. A leg in accordance with claim 9, wherein an elevated platform is couplable to the outer leg.

13. A leg in accordance with claim 9, further comprising:

- a) a channel extending longitudinally along an inner wall of the outer leg;

- b) a mating channel extending longitudinally along an outer wall of the inner leg, the outer wall of the inner leg corresponding to the inner wall of the outer leg; and
- c) the channel in the inner wall of the outer leg being aligned with the mating channel in the outer wall of the inner leg to form a burr groove between the outer leg and inner leg.

14. A method for reducing movement and noise of a telescoping leg for an elevated platform when a load is placed on the elevated platform, comprising:

- a) sliding an inner leg with respect to an outer leg to a desired length;
- b) aligning an aperture in one of the inner leg or the outer leg with an off-axis slot in the other of the inner leg or outer leg;
- c) placing a pin through the aperture and off-axis slot; and
- d) placing an applied load on the telescoping leg such that a bearing surface of the pin contacts a bearing surface of the off-axis slot to force the pin against the bearing surface of the off-axis slot and push the inner leg against the outer leg.

15. A method in accordance with claim 14, further comprising:

- a) removing the pin from the aligned aperture and off-axis slot;
- b) aligning the aperture with a different off-axis slot to change the desired length; and
- c) placing the pin through the aperture and a different off-axis slot.

16. A method in accordance with claim 14, further comprising:

- a) supporting a portable elevated platform with the telescoping leg.

* * * * *

Appendix E. Patent for locking mechanism for telescoping legs

United States Patent [19]
Nakatani

[11] Patent Number: 4,761,092
[45] Date of Patent: Aug. 2, 1988

[54] LOCK FOR TELESCOPING TUBULAR LEG

[76] Inventor: Koma Nakatani, 12-17 2 Chome Nakni, Shinjuku-ku Tokyo, Japan, 161

[21] Appl. No.: 900,221

[22] Filed: Jul. 31, 1986

Related U.S. Application Data

[63] Continuation of Ser. No. 657,912, Oct. 5, 1984, abandoned.

[51] Int. Cl.⁴ F16B 7/10; F16D 1/12

[52] U.S. Cl. 403/104; 403/109;

403/328; 403/374; 248/188.5

[58] Field of Search 403/104, 109, 315, 363, 403/374, 108, 379, 378, 328; 248/168.5, 412, 337, 336

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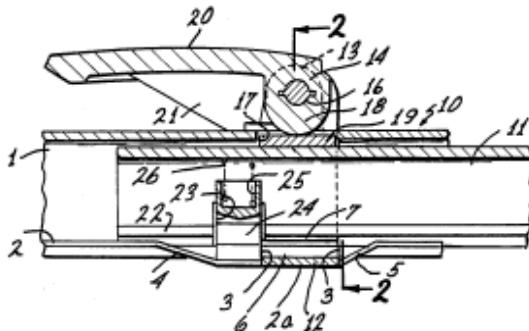
Primary Examiner—Randolph A. Reese

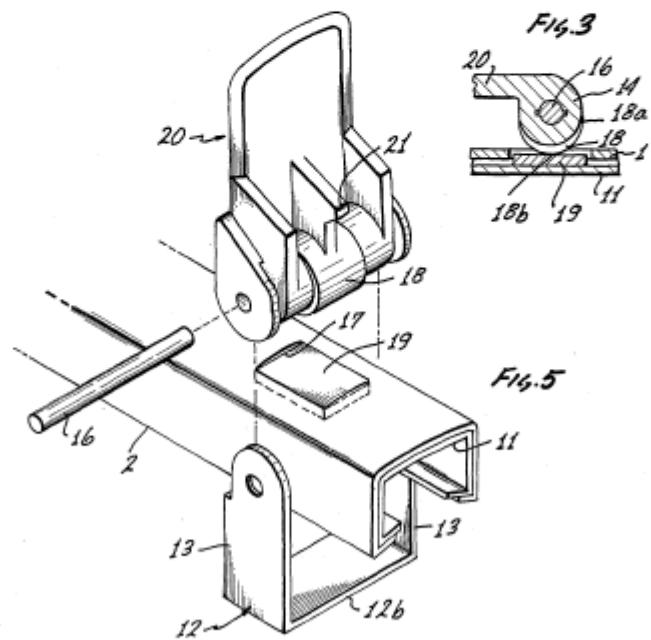
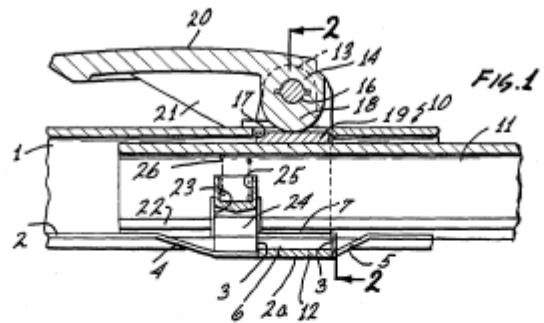
Assistant Examiner—Peter M. Cuomo

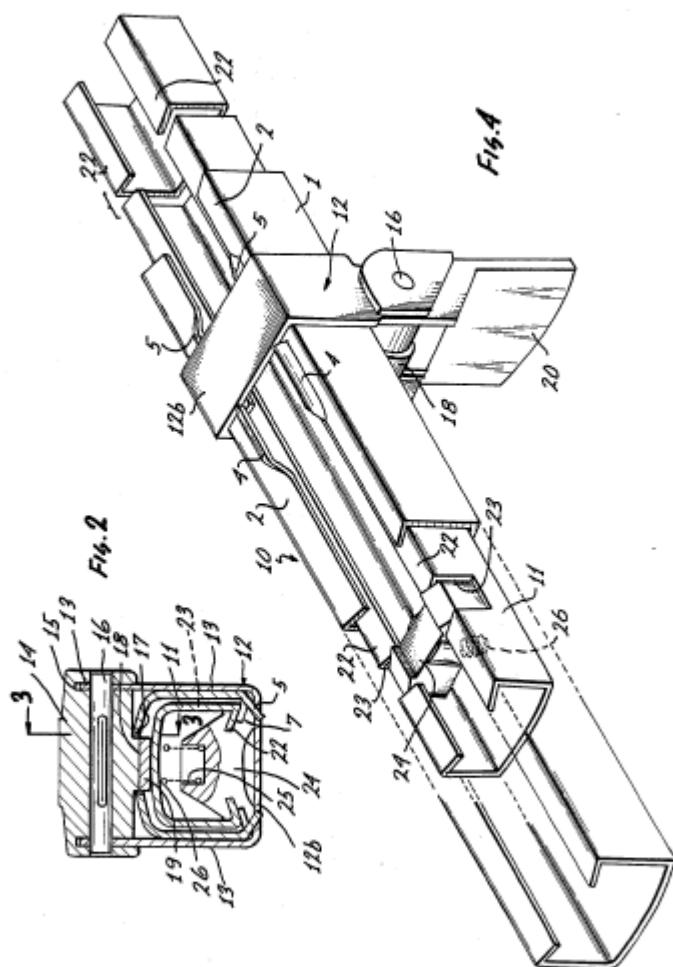
[57] ABSTRACT

A locking mechanism for a telescoping support, such as a tripod leg, which includes an outer tubular section and a slideable inner tubular section is disclosed. The locking mechanism includes a U-shaped mounting bracket conforming to the cross-sectional shape of the outer tubular section and is held against sliding movement along the outer section by lip portions bent outwardly on either side of the bracket. The bracket is further retained against separation from the outer tubular section by a camming lever pivotably mounted between the two arms of the bracket on the side of the leg section opposite the base portion of the bracket, thereby closing the opening of the bracket. The camming lever is pivotable for cammingly engaging the inner tubular section through a window opening formed in the outer tubular section, thereby to lock the two sections against telescoping movement.

17 Claims, 2 Drawing Sheets







LOCK FOR TELESCOPING TUBULAR LEG

This application is a continuation of application Ser. No. 657,932, filed Oct. 5, 1984, now abandoned.

BACKGROUND OF THE INVENTION**FIELD OF THE INVENTION**

The present invention pertains generally to continuously extendable supports and mechanisms for locking the same at arbitrarily extended positions, and is more particularly directed to a lock for a telescoping tubular leg, particularly for use in a tripod support.

BACKGROUND OF THE INVENTION

Existing tripod legs typically consist of a number of telescoping tubular sections of successively smaller cross section, each slideable within a larger section. Each successive pair of sections is provided with a lock for locking the smaller section against sliding movement within the larger section.

The locks previously used for tripod legs wherein the sections are channels of generally U-shaped cross section, typically are levers provided with a cam element and mounted to the larger diameter leg with the cam disposed over a window in the larger channel section. As the lever is pivoted towards the leg, the cam engages the smaller channel section through the window opening, locking the smaller channel against sliding movement, locking the smaller channel against sliding movement within the larger channel section in a manner well known in the art.

Each channel section has three sides defining the U-shaped cross-section. The free edges of the U-shaped channel are in-turned to form a pair of lips projecting towards each other from opposing side walls of the longitudinal channel and extending the full length of each leg section.

In the past the cam locking levers were mounted to each leg section by means of tubular mounts of rectangular cross section slideable onto the corresponding leg sections and retained in alignment with the window opening by bending portions of the lips of the leg section to immobilize the lock mount against sliding movement after the lock has been correctly positioned.

The aforescribed locks of the prior art are relatively costly in that the lever mounts are typically cast in metal to the particular dimensions required for each leg section. The locks manufactured in this manner have been found costly in terms of the materials and manufacturing required, and are further inconvenient in that additional steps, i.e., bending of the lips, must be carried out on each leg section after installation of the lever mount to secure the lock in place, which is a disadvantage in the manufacturing of such tripod legs.

SUMMARY OF THE INVENTION

The present invention overcomes these and other shortcomings of the prior art by providing a locking mechanism for a telescoping support such as the legs of a tripod. Such a support comprises an outer tubular section and an inner tubular section of smaller cross-sectional dimensions and slideable within the outer tubular section. The improved locking mechanism of the present invention includes a mounting bracket having a base portion joining two arms which extend therefrom, for example, a U-shaped bracket. The mounting bracket is open on one side and is dimensioned to conform to the cross-sectional shape of the outer tubular section such

that the bracket may be fitted directly onto any intermediate portion of the tubular section without necessity of sliding it from one end onto the section as was the case in previously used tubular mounting brackets. The bracket is held against sliding movement along the outer section by lip portions bent outwardly on either side of the bracket. The bracket is further retained against separation from the outer tubular section by a camming lever pivotably mounted between the two arms of the bracket on the side of the leg section opposite the base portion of the bracket, thereby closing the opening of the bracket. The camming lever is pivotable for cammingly engaging the inner tubular section through a window opening formed in the outer tubular section, thereby to lock the two sections against telescoping movement.

The locking mechanism may further comprise a stop member within the inner section spring biased for outward movement against the outer section. The stop member is normally held against such outward movement during telescoping extension of the two sections by the longitudinally extending lips of the outer section. The longitudinally extending lips are deformed in the vicinity of the mounting bracket for providing the aforementioned portions which restrain the bracket against sliding movement along the outer section. These deformed lip portions also are shaped so as to permit limited outward movement of the stop member under spring bias such that the stop member is brought into engagement with lip portions of the outer section limiting further telescoping extension of the inner section relative to the outer section.

In a presently preferred embodiment the tubular sections are each of generally U-shaped cross section defining an open longitudinal channel, and including longitudinally extending inward lips projecting into said channel from either side thereof. Portions of these lips are broken and deformed outwardly of the channel in the vicinity and on either side of the mounting bracket such that the mounting bracket is held captive between the deformed lip portions against sliding movement along the outer section. The outwardly deformed lip portions also allow the stop member to move outwardly under spring urging such that the stop member is brought into abutment with lip portions underlying the bracket so as to limit the outer and inner sections against further telescoping extension. The deformed lip portions are ramped so as to urge the stop member inwardly into the channel and underneath the longitudinally extending lips against the spring bias to thereby readily allow telescoping retraction of the inner section into the outer section.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-sectional view of the locking mechanism with the telescoping sections in fully extended and locked position.

FIG. 2 is an axial cross section taken along line 2-2 in FIG. 1.

FIG. 3 is a fragmentary view illustrating the locking action of the camming lever.

FIG. 4 is a perspective view of the telescoping support in a partially retracted position with the lock in released position, partly broken away to show the extension limiting stop member.

FIG. 5 is a fragmentary exploded view of the lock mechanism.

**DETAILED DESCRIPTION OF THE
PREFERRED EMBODIMENT**

With reference to the drawings and FIG. 1 in particular, a telescoping support particularly suited for use as a tripod leg has an outer leg section 1 and an inner leg section 11 telescopically slideable within the outer leg section 1. A lever 20 provided with a cam portion 18 is pivotably mounted by means of shaft 16 between the parallel arms 13 of a U-shaped mounting bracket 12. The bracket 12 is dimensioned to fit around the outer leg section 1 and is held against detachment from the leg by the camming lever 20 which closes the gap between the bracket arms 13.

The cross section of each leg section 1 and 11 is generally U-shaped defining a longitudinally extending channel and include in-turned lips 2 which project inwardly towards each other within the channel, and which extend longitudinally the entire length of each section. Each lip 2 of the outer section 1 is cut at two points 3, and portions of the lips in the vicinity of the cuts are deformed by bending outwardly of the channel. This deformation creates two ramps 4, 5 with a recess 6 between the deformed lip portions 4 and 5 in which lie undeformed lip portions 7.

As best seen in FIG. 4, the U-shaped mounting bracket 12 is mounted to the outer leg section 1 intermediate the deformed lip portions 4 and 5 with the base portion 12b of the mounting bracket bridging the open channel of the leg section between the longitudinally extending lips 2. The bracket is thus held against sliding movement along the leg section 1 between the ramped lip portions 4 and 5. The camming lever 20 is mounted between the arms 13 of the bracket 12 by inserting a shaft 16 through aligned holes in the lever 20 and the arms 13, thus enabling the camming lever 20 to pivot between a down or locking position shown in FIG. 1 and an up or release position shown in FIG. 4 where the lever 20 is brought to a generally perpendicular position to the leg section 1 by pivoting the lever approximately 90 degrees away from the telescoping leg. A cam element 18 is provided on the lever 20 such that it overlies a window opening 17 defined in the outer leg section 1. A pressure plate 19 is disposed within the window opening, and is captive between the inner leg section 11 and the cam 18. In the locked position the cam 18 has a portion of greater radius 18b, shown in FIG. 3, which presses against the plate 19, which in turn presses against the inner leg section 11, creating a friction lock between the inner section 11 and the outer section 1 to prevent telescoping movement between the two sections. Desirably, the camming lever 20 is provided with a lever stop portion 21 which limits the locking movement of the lever towards the outer section 1, thereby correctly positioning the cam 18 with its maximum radius portion against the plate 19. The lock is released to allow telescoping sliding movement of the two leg sections by pivoting the lever 20 approximately 90 degrees to a generally erect position so that the cam portion 18b of large radius is rotated away from the plate 19, and the smaller radius portion 18a of the cam 18 overlies the plate 19, but does not press against the same.

The inner leg section 11 has opposing notches 23 cut into each of the longitudinally extending lips 22. A stop member 24 is held captive against longitudinal movement within the notches 23, but is free to move outwardly of the channel of the inner leg section 11, i.e.,

along a direction perpendicular to the telescoping axis of the support assembly 10. A coil spring 26 is compressed within a bore 25 between the end stop 24 and the bottom wall of the inner leg section 11, as best seen in FIG. 2, such that the stop member is normally urged by the spring 26 against the lips 2 of the outer leg section 1 during telescoping extension of the two leg sections. However, as the stop member 24 is moved towards the mounting bracket 12, the stop member moves underneath the ramped lip portions 4 which allow the stop member to move outwardly of the inner leg section 11 under the urging of spring 26. The stop member is thus brought into abutment with the undeformed lip portions 7 which underlie the mounting bracket 12, thereby preventing further telescoping extension of the leg sections 1 and 11. Normally the bracket 12 will be mounted near one end of the larger leg section 1, while the stop member 24 will be disposed in notches 23 cut into the lips of the inner leg section 11 near an opposite end of the inner section 11, so as to lock the two sections against telescoping extension near the maximum possible extension of the two sections.

The camming lever 20 can be operated at any relative position of the two leg sections 1 and 11, so as to lock the two leg sections at any arbitrary extension of the two sections to thereby obtain a support member or leg which is continuously variable in length.

The support bracket 12 may be easily and inexpensively manufactured by bending flat sheet stock such as elongated pieces of sheet steel into a U-shape and providing the bracket with the aligned holes necessary for receiving the lever shaft 16, thus realizing substantial savings in material and labor over tripod legs using the tubular lever mounts of the prior art.

While a particular embodiment of the invention has been shown and illustrated for purposes of clarity it will be understood that many changes, alterations and substitutions are possible without departing from the spirit and scope of the invention, which is limited only by the following claims:

I claim:

1. A lockable telescoping support comprising an outer and an inner channel section, a U-shaped mounting bracket having two arms connected by a base portion with each arm having a free end; said bracket mounted to the outer channel section and held against sliding movement therealong between deformed portions of said outer section; said bracket being retained against separation from said outer section only by a camming lever pivotably mounted between said free ends of said bracket for cammingly engaging the inner channel section through a window formed in the outer channel section thereby to lock said two sections against telescoping movement; and

a stop member mounted to said inner section, said stop member being spring biased toward said outer section, longitudinally extending portions on the outer section for restraining said stop member against said spring bias during telescoping extension of said sections, said longitudinally extending portions being deformed in the vicinity of said mounting bracket for restraining the mounting bracket against sliding movement and also allowing movement of said stop member under spring bias into abutment with portions of said outer section to thereby limit further telescoping extension of said sections.

2. The lockable telescoping support of claim 1 wherein each channel section is of generally U-shaped cross section defining an open longitudinal channel and including longitudinally extending inturned lips projecting into said channel, portions of said lips being broken and deformed outwardly of said channel in the vicinity and on either side of said mounting bracket, said bracket thus being captive between said deformed lip portions against sliding movement along said outer section.

3. The lockable telescoping support of claim 1 wherein each channel section is of generally U-shaped cross section defining an open longitudinal channel and including longitudinally extending inturned lips projecting into said channel, portions of said lips being broken and deformed outwardly of said channel in the vicinity and on either side of said mounting bracket, said bracket being captive between said deformed lip portions against sliding movement along said outer section, said outwardly deformed lip portions allowing outward movement of said stop member under spring bias into abutment with said lip portions underlying said bracket to thereby limit said outer and inner sections against further telescoping extension.

4. The lockable telescoping support of claim 3 wherein said lip portions underlying said bracket are not deformed.

5. The lockable telescoping support of claim 3, wherein said deformed lip portions ramp outwardly of said channel so as to urge said stop member inwardly into said channel underneath said longitudinally extending lips against said spring bias during telescoping retraction of said inner section into said outer section.

6. The lockable telescoping support of any one of claims 1 through 3 further comprising a pressure plate disposed in said window and captive between said inner section and said camming lever.

7. The lockable telescoping support of claim 3, wherein said stop member is held against longitudinal displacement along said inner channel section within opposing notches cut in said lips of the inner section.

8. The lockable telescoping support of claim 7 wherein said stop member is urged outwardly of the inner channel section by a spring compressed between said inner section and said stop member.

9. The lockable telescoping support of claim 8, wherein said compressed spring is a coil spring.

10. The lockable telescoping support of claim 2, or claim 3 wherein said mounting bracket is a piece of sheet material bent into a U-shape having a pair of arms joined by a base portion, said base portion bridging said open channel.

11. The lockable telescoping support of claim 2 or claim 3 wherein said camming lever is provided with stop means for limiting pivotal movement of the lever towards said outer section.

12. The lockable telescoping support of claim 1 wherein said mounting bracket is a piece of sheet material bent to conform to the cross-sectional shape of said outer section.

13. A lock for a telescoping support of the type including an inner channel section telescopingly slideable within an outer channel section, said lock comprising: a mounting bracket having a base portion and joining two parallel arms, said bracket being mounted to the outer channel section and held against sliding

movement therewith by portions integral with said outer section, said bracket being retained against separation from said outer section by a camming lever pivotally mounted between said two arms for cammingly engaging the inner channel section through a window formed in the outer channel section thereby to lock said two sections against telescoping movement;

a stop member mounted to said inner channel section and spring biased against longitudinally extending portions on the outer section during telescoping extension of said channel portions, said longitudinally extending portions being outwardly bent in the vicinity and on either side of said mounting bracket for restraining the mounting bracket against sliding movement along the outer section, said outwardly bent longitudinal portions also allowing movement of said stop member under spring bias into abutment with portions of said outer section to thereby limit further telescoping extension of said sections.

14. The lock of claim 13 wherein each said channel section is of generally U-shaped cross section defining an open longitudinal channel and wherein said longitudinally extending portions are inturned lips projecting from opposed side walls into said channel.

15. The lock of claim 14 wherein said deformed longitudinal portions are lip portions ramping outwardly of said channel so as to allow said stop member to move gradually outwardly of said channel under spring bias, and also for urging said stop member inwardly into said channel underneath said longitudinally extending lips against said spring bias during telescoping retraction of said inner section into said outer section.

16. The lock of claim 13, 14 or 15 wherein said mounting bracket is a piece of sheet material bent to conform to the cross-sectional shape of said outer section.

17. A lock for an extendable support of the type including an inner channel section telescopingly slideable within an outer channel section, said channel sections being of U-shaped cross section, each channel section including longitudinally extending lips projecting towards each other from opposing side walls in said channel, said lock comprising:

a U-shaped mounting bracket mounted to the outer channel section and held against sliding movement therewith by ramped lip portions adjacent to either side of said bracket, said bracket being retained against separation from said outer section by a camming lever pivotally mounted between the two arms of the bracket for cammingly engaging the inner channel section through a window defined in the outer channel section thereby to lock together said two sections against telescoping movement; and

a stop member mounted to said inner section and spring biased against the longitudinally extending lips of the outer channel section during telescoping extension of the two sections, said ramped lip portions allowing movement of said stop member under spring bias into abutment with lip portions underlying said mounting bracket to thereby limit further telescoping extension of the two channel sections.

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